Phase II
Water Quality
Technical Team
Reports

CALFED

Water Quality Technical Group

December 9, 1996
Meeting Packet

CALFED
BAY-DELTA
PROGRAM

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CALFED WATER QUALITY ACTION LIST

CALFED/375

CALFED Water Quality Actions

Priority Actions

Action 1: Control the timing of agricultural drainage discharge to coincide with periods when dilution flow is sufficient to achieve CALFED water quality target concentrations. (Agricultural Drainage)

Action 11: Implement additional agricultural source control for water quality parameters of concern found in agricultural surface and sub-surface drainage. Implementation may include incentives and/or enforcement of existing regulations. (Agricultural Drainage)

Action 13: Provide incentives to fallow or retire land that is a major source of water quality parameters of concern. Landowner participation should be voluntary and by compensated purchase or lease payment. (Agricultural Drainage)

Action 19. Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through provision of incentives for additional source control of urban and industrial runoff. An example of an incentives might be to provide rebates on construction permit fees when erosion control measures have been applied. (Urban and Industrial Runoff)

Action 20. Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through better planning of new developments to reduce urban and industrial runoff. Examples of better planning might include design of storm drainage systems that target maximum infiltration of stormwater into the ground or on-site or regional stormwater sedimentation facilities that detain the majority of stormwater for at least 8 hours. (Urban and Industrial Runoff)

Action 21: Promote and support efforts of local watershed programs that improve water quality parameters of concern within the Delta and Delta tributary watersheds. Efforts may include coordination, incentives, and/or other assistance. (Watershed Coordination)

Action 22A: Reduce metal loadings (e.g. cadmium, copper, mercury and zinc) to the Delta and its tributaries by implementation of moderate on-site mine drainage remediation measures developed in site-specific studies at inactive mine sites. (Mine Drainage)

Action 22B: Reduce metal loadings (e.g. mercury) to the Delta and its tributaries by implementation of moderate on-site mine drainage remediation measures developed in site-specific studies at abandoned mine sites. (Mine Drainage)

Action 23: Control discharges of domestic wastes from boats within the Delta and Delta tributaries by more extensive enforcement of existing regulations. (Wastewater and Industrial Discharges)

Action 31: Identify and implement actions to address potential toxicity to water and sediment within the Delta and its tributaries by conducting toxicity testing and toxicity identification evaluations and/or other appropriate methods. Coordinate these efforts with other programs. (Watershed Coordination)

Action 32A: Provide incentives for pesticide users to increase implementation of best management practices (BMPs) including integrated pest management (IPM) to reduce pesticide loads and concentrations to the Delta and its tributaries from urban & industrial runoff. (Urban and Industrial Runoff)

Action 32B: Implement additional agricultural source control for water quality parameters of concern found in agricultural surface and sub-surface drainage. Implementation may include provision of incentives for pesticide users to increase implementation of best management practices (BMPs) including integrated pest management (IPM) to reduce pesticide loads and concentrations from agricultural drainage. (Agricultural Drainage)

Other Actions

Action 2: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) from willing sellers. Action is primarily targeted at the San Joaquin River. (Dilution)

Action 3: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet). Water would be acquired by providing incentives for more efficient water management of dams, including reservoir re-operation. Action is primarily target primarily at the San Joaquin River. (Dilution)

Action 4: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) through urban water conservation. Action is primary targeted at the San Joaquin River. Conservation might be achieved through use of incentives for implementation of best management practices by more suppliers and water users. Implementation of the action may reduce demand for existing water and may make dilution water available (including transfers), especially on the San Joaquin River. (Dilution)

Action 5: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) through greater use of reclaimed wastewater. Action is primarily targeted at the San Joaquin River. Reclamation projects could include: recharge groundwater, use for agricultural irrigation, recycling and treating for potable or non-potable urban, use of grey water, and storage for use in meeting X2 standards. Reclamation programs would focus on facilities that currently discharge treated wastewater to salt sinks or other degraded bodies of water that are not reusable. (Dilution)

Action 6: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries by treating agricultural drainage and releasing it during periods of low flow for dilution purposes. (Dilution)

Action 7: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring additional dilution water through enhanced seasonal recharge and development of additional groundwater supplies. Water would be used for dilution, especially on the San Joaquin River. (Dilution)

Action 8: Improve water circulation in the Delta by development of improvements at the head of Old River to block fish movement into Old River and by management of water flow and stage down Old River. (Agricultural Drainage)

Action 9: Reduce the vulnerability of Delta water quality to salinity intrusion through implementation of the Delta Long-Term Protection Plan (including levees O & M). (Watershed Coordination)

Action 10: Combined with Action 11. (Agricultural Drainage)

Action 12: Improve source irrigation water quality in sub-surface drainage source areas. All things being equal, higher quality irrigation water will result in better quality drainage. (Agricultural Drainage)

Action 14: Reduce the loadings of water quality parameters of concern entering the Delta and San Joaquin tributaries by concentrating and disposing of agricultural sub-surface drainage in evaporation ponds in the San Joaquin Valley. (Agricultural Drainage)

Action 15: Reduce the loadings of water quality parameters of concern entering the Delta and its tributaries by treating agricultural surface drainage and/or Delta agricultural sub-surface drainage in constructed wetlands. (Agricultural Drainage)

Action 16: Reduce the loadings of water quality parameters of concern entering the Delta and San Joaquin tributaries by treating a significant portion of San Joaquin agricultural sub-surface drainage by reverse osmosis or other means. (Agricultural Drainage)

Action 17: Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries by detention and strategic release of 20 to 30 percent of urban runoff water. Action would involve retrofitting existing urban and industrial areas with detention basins at the outlets of drainage basins contributing largest loadings of parameters of concern. (Urban and Industrial Runoff)

Action 18: Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through enforcement of existing source control regulations for urban and industrial runoff. (Urban and Industrial Runoff)

Action 24: Reduce water quality parameters of concern loadings to the Delta and its tributaries by treating a portion of upstream municipal wastewater effluent in wetlands. (Wastewater and Industrial Discharges)

Action 25: Reduce point source water quality parameters of concern loadings to the Delta and its tributaries through cost effective control of industrial and municipal wastewater discharges. Methods may include encouragement of pollutant credit trading. (Wastewater and Industrial Discharges)

Action 26: Reduce the formation of disinfection by-products, and their concentration in the domestic water supply, resulting from the use of chlorine in water treatment plants. Conversion of facilities from chlorine to ozone would serve to reduce the formation of disinfection by-products. (Water Treatment)

Action 27: Reduce point source water parameters of concern loadings to the Delta and its tributaries through control of industrial and municipal wastewater discharges. Methods may include incentives for reclamation and reuse. (Wastewater and Industrial Discharges)

Action 28A: Improve treated drinking water quality parameters of concern by providing incentives for the addition of enhanced coagulation, ozone, granular activated carbon filtration and/or membrane filtration facilities to the water systems treating water from the Delta. (Water Treatment)

Action 28B: Improve source water quality parameters of concern at domestic water supply intakes, as identified in the geographic scope, by reducing Delta Island discharges that are high in TOC or other compounds that impact source water quality, or by relocating water supply intakes to areas that are not influenced by those discharges. (Water Treatment)

Action 29: Improve water quality parameters of concern within the Delta and its tributaries by restoring or improving riparian habitat. (Watershed Coordination)

Action 30: Combined into Action 29. (Watershed Coordination)

ATTACHMENT A

MINE DRAINAGE ACTIONS

Actions to Reduce Loadings/Concentrations of CALFED Water Quality Parameters of Concern due to Mine Drainage

REDUCTION IN PARAMETER OF CONCERN LOADINGS DUE TO MINE DRAINAGE

(Actions 22A, 22B)

Goal

The goal of these actions is to maintain or improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e. g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to reduce the loading and/or concentration of water quality parameters of concern attributable to mine drainage within the Sacramento River and San Joaquin River Basins, Delta and Suisun Marsh.

Geographic Scope

[Work in Progress]

The geographic scope is defined as all of the following:

- areas within the Delta
- areas outside of the Delta in which biological resources that use the Delta are impacted
- areas outside of the Delta that are significant source areas for parameters of concern in the Delta

Thus, the Sacramento River above Red Bluff Diversion Dam would be in-scope with respect to the impact of metals concentrations and anadromous fish, but out of scope with respect to impacts on organisms unrelated to Delta biological resources. Also, Salt Slough is in-scope as a significant source of salt and trace element loading to the Delta.

The majority of mine drainage problems are either directly or indirectly associated with the mining of gold. The Central Valley Regional Water Quality Control Board (CVRWQCB) presently manages 94 inactive mines under Waste Discharge Requirement (WDR) and NPDES permitting programs. Sampling during the period of 1987 through 1992 indicates that 80 percent of cadmium, 72 percent of zinc and 73 percent of copper in the Sacramento River comes from past gold mining activities.

Acid mine drainage (AMD) can be generated by active or inactive mines. During the oxidation of pyrite sulfide ores sulfuric acid is formed. This acid dissolves and releases metals in the surrounding rock. The largest concentrations of metals released include copper, zinc and cadmium.

The greatest concentration of gold mines can be found around Shasta Lake, with Iron Mountain Mine complex being considered the largest AMD pollutant source in the Central Valley. Other mines can be found in the western slope foothills of the Sierra Nevada Mountains. The most notable mines are the Penn, Walker, Cherokee and Newton Mines.

Figure locates some of the larger mines mine regions in the Central Valley.

Mercury has been used historically to refine gold from gold bearing ore. The mercury binds with the gold to form an amalgam. The compound is then heated in the presence of nitric acid to separate the mercury from the gold. Much of the waste mercury was lost or mishandled during the refining process. The majority of the California mercury mines were located on the western side of the Central Valley and the majority of the gold mines were located on the eastern side of the Central Valley. This required the mining and transport of large volumes of mercury across the valley. It is estimated that 70 million tons of mercury were transported this way during the Gold Rush Era. The CVRWQCB currently monitors six inactive mercury mines. The most notable are the Corona, Manzanita, New Idria and Mt. Diablo Mines. Effects of past mercury mining and gold refining operations are being studied on Cache Creek and the Consumnes River.

Parameters of Concern Attributable to Mine Drainage

- Copper
- Cadmium
- Zinc
- Mercury

Estimated Parameter of Concern Loadings Due to Mine Drainage

[Work in Progress]

Limited research has been conducted to estimate the loads from inactive mines. Table 1 illustrates findings from the CVRWQCB studies conducted during the period of 1987 through 1991. Only loadings for cadmium, zinc and copper are presented.

Current Programs

[Work in Progress]

Cadmium, Zinc, and Copper

Remediation efforts are being conducted on over 8 inactive mine sites in the Sacramento River Basin. The most well-known work is being conducted at the Iron Mountain Mine complex. Work effort includes, but is not limited to, construction of dams, installation of treatment facilities and the construction of bulkheads in the mine portals. Additional work is being performed on other Shasta Lake Area Mines. The majority of the work to-date has focused on portal closures.

TABLE 1

LOADING ESTIMATES FROM INACTIVE MINES WITH PERENNIAL DISCHARGES DURING A DROUGHT PERIOD, 1987-91

	Total Annual Loads in Kilograms (Percent of Total in Parentheses) (NA=not available; ND=not detected)[7]					
Mine Site Discharge	**Cadmium**		**Copper**		**Zinc**	
SCDD[3]	1,529	(85)	36,300	(57)	209,352	(80)
Little Backbone Creek and Shoemaker Gulch mines[5]	186	(10)	19,961	(30)	36,760	(14)
West Squaw Creek mines[4]	38	(2.1)	6,928	(11)	7537	(2.9)
SRCSD (1985)[2]	60		2,863		15,340	
Afterthought[1]	12	(0.66)	488	(0.76)	3,008	(1.15)
Rising Star	12	(0.66)	260	(0.41)	2,603	(1.00)
Valley View	19	(1.1)	428	(0.67)	850	(0.33)
Kanaka Creek mines	NA	(0.00)	NA	(0.00)	NA	(0.00)
Spanish (upper and lower)	0.66	(0.037)	61	(0.09)	191	(0.07)
Brush Creek	ND	(0.00)	1.3	(0.002)	ND	(0.00)
Bully Hill	7	(0.37)	135	(0.21)	359	(0.14)
Spenceville	0.09	(0.005)	175	(0.27)	144	(0.06)
Greenhorn	1	(0.05)	122	(0.19)	232	(0.09)
Corona	ND	(0.00)	ND	(0.00)	18	(0.01)
Plumbago	ND	(0.00)	0.21	(0.00)	ND	(0.00)
Malakoff Diggings	ND	(0.00)	14	(0.02)	28	(0.01)
Empire	ND	(0.00)	ND	(0.00)	2.9	(0.00)
Lucky S	0.31	(0.02)	8.2	(0.01)	34	(0.01)
Lava Cap	0.04	(0.002)	0.37	(0.001)	3.4	(0.00)
Columbo	ND	(0.00)	ND	(0.00)	ND	(0.00)
Walker	0.002	(0.00)	4	(0.01)	0.18	(0.00)
Iron Dyke (Taylors Creek)	0.032	(0.002)	1.3	(0.002)	1.1	(0.00)
Twin Peaks	0.001	(0.00)	ND	(0.00)	0.22	(0.00)
Pick and Shovel	ND	(0.00)	ND	(0.00)	0.98	(0.00)
Reed	ND	(0.00)	ND	(0.00)	0.1	(0.00)
Anderson Springs	ND	(0.00)	0.27	(0.00)	1.8	(0.00)
Champion	0.05	(0.003)	0.07	(0.00)	0.78	(0.00)
Great Western	ND	(0.00)	0.01	(0.00)	0.16	(0.00)
Turkey Run	ND	(0.00)	ND	(0.00)	ND	(0.00)
TOTAL LOADS[6]	**1,805**		**63,889**		**261,128**	

[1]Loads were calculated using data from 1984.

[2]Sacramento Regional County Sanitation District wastewater treatment plant loads, 1985.

[3]SCDD = Spring Creek Debris Dam release. The SCDD watershed drains Iron Mt. and Stowell Mines.

[4]The sum of the loads coming from Balaklala, Keystone, Early Bird, and Shasta King Mines.

[5]The sum of the loads coming from Mammoth, Golinsky, and Sutro Mines.

[6]Excludes SRCSD loads.

[7]Loading values do not exclude uncertain digits.

Mercury

No mercury remediation projects have been identified.

Effectiveness of Current Programs

[Work in Progress]

Since the majority of the work accomplished to-date has been around the remediation work being accomplished at the Iron Mountain Mine Complex and neighboring mine site, only data associated with this area are available. The following table, Table 2, illustrates the effectiveness of the current program.

Priority Actions to Reduce Impacts of Mine Drainage

[Work in Progress]

Action 22A: Reduce metal loadings (e.g. cadmium, copper, mercury and zinc) to the Delta and its tributaries by implementation of moderate on-site mine drainage remediation measures developed in site-specific studies at inactive mine sites.

<u>Expected Benefits:</u>

<u>Other Considerations:</u>

Action 22B: Reduce metal loadings (e.g. mercury) to the Delta and its tributaries by implementation of moderate on-site mine drainage remediation measures developed in site-specific studies at abandoned mine sites.

<u>Expected Benefits:</u>

<u>Other Considerations:</u>

References:

Fujimara, Robert W., et al., Chemical and Toxicological Characterization of Keswick Reservoir Sediments, 1995.

Montoya, Barry L. and Xiaomang Pan, Inactive Mine Drainage in the Sacramento Valley, California, 1992.

Montoya, Barry L., An Analysis of the Toxic Water Quality Impairments in the Sacramento-San Joaquin Delta/Estuary, 1991.

TABLE 2

Mine	lbs/day Copper Pre-Remediation (1980)	lbs/day Copper Current
Iron Mountain	800	200
Mammoth	70	70
Balaklala	200	20
Shasta King	3	1
Sutro	0.5	0.1
Golinsky	1	1
Afterthought	5	5
Greenhorn	4.5	4.5
Bully Hill	4	4
Rising Star	5	5
Keystone	3	3
Stowell	3.5	2.5
Early Bird	3	0.1
TOTAL	1102.5	316.2

Montoya, Barry L., et al., A Mass Loading Assessment of Major Point and Non-point Sources Discharging to Surface Waters in the Central Valley, California, 1985.

Montoya, Barry L., et al., A Mass Loading Assessment of Major Point and Non-point Sources Discharging to Surface Waters in the Central Valley, California, 1989.

Pacheco, Victor,. et al., The Effectos of Toxic Contaminants in Waters of the San Francisco Bay and Delta, no date.

Sugarek, Richard, Iron Mountain Mine, Shasta County, California, unpublished.

State Water Resources Control Board, Report of the Technical Advisory Committee for Abandoned Mines, 1994.

URBAN & INDUSTRIAL RUNOFF ACTIONS

Actions to Reduce Loadings/Concentrations of CALFED Water Quality Parameters of Concern due to Urban & Industrial Runoff

URBAN AND INDUSTRIAL RUNOFF ACTIONS TO REDUCE LOADINGS OF PARAMETERS OF CONCERN

(Actions 17, 18, 19, 20, 32A)

Goal

The goal of these actions is to maintain or improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e.g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to reduce the loading and/or concentration of water quality parameters of concern attributable to URBAN AND INDUSTRIAL RUNOFF within the Sacramento River and San Joaquin River Basins, Delta and Suisun Marsh.

Geographic Scope

The geographic scope is defined as all of the following:

- areas within the Delta
- areas outside of the Delta in which biological resources that use the Delta are impacted
- areas outside of the Delta that are significant source areas for parameters of concern in the Delta

Thus, the Sacramento River above Red Bluff Diversion Dam would be in-scope with respect to the impact of metals concentrations and anadromous fish, but out of scope with respect to impacts on organisms unrelated to Delta biological resources. Also, Salt Slough is in-scope as a significant source of salt and trace element loading to the Delta.

Parameters of Concern Attributable to Urban and Industrial Runoff

- Copper
- Zinc
- Mercury
- Carbofuran
- Chlorpyrifos
- Diazinon
- Ammonia
- Dissolved Oxygen
- Sodium
- SAR
- Salinity
- Pathogens

- pH
- TDS
- TOC
- Turbidity
- Nitrate

Estimated Parameter of Concern Loadings due to Urban and Industrial Runoff

[Work In Progress]

Estimates of the total annual pollutant loads contained in stormwater runoff from urban and industrial lands are shown in Table 1. These estimates assume that the quality of urban runoff from the city of Sacramento is representative of all urban and industrial lands in the study area. Most, but not all, of these pollutant loads will reach the Delta. Some non-conservative pollutants such as BOD, ammonia and microbial pathogens may decay during transit in tributary streams. Others may become absorbed onto particulate material and settle to the bottom of streams where they may remain until moved downstream by large stream flows.

Urban and industrial stormwater pollutants are typically delivered to natural surface waters by a combination of underground drainage pipes and open channels. Flow to surface waters from urban drainage systems is greatest during storms but continues during dry periods and periods between storms. During non-storm periods water enters urban drainage systems from the ground and as surface runoff from poorly adjusted irrigation systems, car-washing, etc. Data gathered in Sacramento indicates that flow from urban drainage systems during dry weather and between storms contains fewer pollutants than stormwater runoff but higher concentrations of minerals.

In the Sacramento Valley most stormwater runoff occurs between November and April when river flow and dilution is greatest. As a result, surface runoff has less impact on pollutant concentrations in Delta water than it would if it occurred during the low flow months. The effects of urban runoff are more likely to be felt in small creeks within or adjacent to the urban area where urban runoff represents a large proportion of total flow.

Water Quality Problem Areas for Parameters of Concern

[Work In Progress]

This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento, and San Joaquin rivers will be identified.

TABLE 1
ESTIMATED STUDY AREA URBAN/INDUSTRIAL RUNOFF LOADS[1]

Constituent	Total Pollutant Load (tons/yr)	Remarks
Total Copper	14.2	
Total Zinc	108	
Total Mercury	0.2	
Carbofuran		
Chlorpyrifos		
Diazinon	0.2	
Ammonia	400	
Dissolved Oxygen	Not Estimated	Non usually measured in urban runoff. See BOD.
Sodium		
SAR		
Salinity		Concentration in urban runoff lower than in Sacramento River water upstream of Delta.
Pathogens		
pH		pH of urban runoff usually in normal range for unpolluted waters.
TDS	39,000	Concentration in urban runoff lower than in Sacramento River water upstream of Delta.
TOC	See BOD	Not commonly measured in urban runoff.
Turbidity	See TSS	
Nitrate	1,100	
Total Suspended Solids	52,000	
BOD	11,000	

[1]Additional information will be added as it is obtained.

Current Programs

[Work in Progress]

Large Cities

In the early 1990s, cities with populations exceeding 100,000 people prepared stormwater management plans pursuant to the Clean Water Act (USC) $1,251 et seg). The plans include a number of "best management practices" (BMPs) designed to reduce stormwater pollutants. Best management practices include non-structural source control measures and structural controls. Commonly employed non-structural source controls include stenciling of catch basins and drain inlets, and public education to discourage disposal of inappropriate substances to the storm drains. Structural controls include stormwater treatment devices and elimination of illicit sanitary connections to storm drainage systems. Most current stormwater plans emphasize non-structural source controls, essentially urban "good housekeeping". They also typically include the elimination of illicit connections. Few plans call for retrofitting urban storm drainage systems with treatment devices, although some require the installation of treatment in new developments.

Small Cities

Regulations for control of stormwater discharges from cities with populations less than 100,000 have not yet been promulgated by the U.S. Environmental Protection Agency.

Industries

Most industries with the potential to contaminate stormwater runoff are required to obtain a discharge permit pursuant to the Clean Water Act. The requirement applies whether stormwater from the industry is discharged directly to the environment or to a municipal stormwater system. Permits typically require that an industry prepare, maintain, and implement a stormwater management plan that includes a variety of source control best management practices such as covering stored materials and routing heavily contaminated washwater and stormwater to the sanitary sewer.

Effectiveness of Current Programs

[Work In Progress]

Most urban stormwater management plans including those developed for large cities in the study area (Sacramento, Stockton, Modesto, etc.) are in the early stages of implementation. Consequently, little data are available by which to judge their effectiveness. The data that are available indicate that source control measures do not produce major improvements in runoff quality. While education may change some human behavior, for example illicit dumping in storm drains, it is doubtful that the targeted human behaviors contribute greatly to the overall urban runoff pollutant load. It is unlikely that programs that emphasize source controls and elimination of illicit connections will substantially reduce existing urban runoff pollutant loads. Most of the more significant urban runoff pollutants are probably attributable to vehicle use, air pollutant fallout and wash-off from buildings. Such sources are beyond the range of most current regulations and are difficult to control.

Programs that involve structural controls as well as source controls are likely to be more effective than current programs. Retrofitting structural controls into existing urban development is difficult and expensive and consequently rarely undertaken. Building structural controls into new development is more practical than retrofitting existing systems.

Priority Actions to Reduce Impacts of Urban and Industrial Runoff

Action 17: Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries by detention and strategic release of 20 to 30 percent of urban runoff water. Action would involve retrofitting existing urban and industrial areas with detention basins at the outlets of drainage basins contributing largest loadings of parameters of concern.

Expected Benefits: This action would involve retrofitting existing urban and industrial areas with detention basins at the outlets of drainage basins with the highest potential for contamination of stormwater. Pollutants would be removed from runoff by sedimentation. The following removal rates are assumed for stormwater detained for eight hours; total suspended solids, 65 percent; biochemical oxygen demand, 30 percent; ammonia and nitrate nitrogen, 25 percent; total copper and mercury and diazinon, 50 percent; and total zinc, 45 percent. Other parameters of concern would be unaffected. If it is assumed that 25 percent of runoff is treated and that it is 50 percent more polluted than typical urban runoff, the total annual urban and industrial runoff loads would be reduced as shown on Table 2.

Other Considerations: Retrofitting detention basins into existing urban development is often difficult and expensive. In many cases several acres of land is needed at a drainage system outlet to accommodate a detention basin. Parcels of this size are rarely available in developed urban areas without acquisition of private land and demolition of existing structures.

Compatibility with On-going Programs: Action 17 is compatible with on-going programs both external and internal to CALFED. It could best be implemented by building on the existing stormwater regulatory program established pursuant to the Clean Water Act and administered by the Regional Water Quality Control Board. To be effective, the existing program would have to be expanded to cover cities with a population of less than 100,000.

Action 18: Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through enforcement of existing source control regulations for urban and industrial runoff.

Expected Benefits: This action would involve increasing regulatory pressure to ensure that existing source control regulations are fully enforced. Source control measures are probably more effective for industrial rather than urban runoff. Source control measures have little effect on contaminants from vehicular movements, an important source of pollutants in urban stormwater. It is estimated that constituent loads in urban runoff could be reduced by source control as follows: diazinon, 5 percent; ammonia and nitrate nitrogen, 5 percent; total suspended solids, 10 percent. All other

TABLE 2
EFFECTIVENESS OF PROPOSED ACTIONS

Constituent	Total Pollutant Load (tons/year)		
	Current	With Action 17	With Action 18
Total Copper	14.2	11.5	14.2
Total Zinc	108	90	108
Total Mercury	0.2	0.16	0.2
Diazinon	0.2	0.16	0.19
Ammonia	400	362	380
TDS	39,000	39,000	39,000
Nitrate	1,100	997	1,045
TSS	52,000	39,000	46,800
BOD	11,000	9,800	11,000

constituents would be unaffected. The effect of Action 18 on total runoff loads is shown in Table 2.

Other Considerations: None.

Compatibility with On-going Programs: Action 18 is compatible with on-going programs both external and internal to CALFED. It could best be implemented by building on the existing stormwater regulatory program established pursuant to the Clean Water Act and administered by the Regional Water Quality Control Board. To be effective, the existing program would have to be expanded to cover cities with a population of less than 100,000.

Action 19. Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through provision of incentives for additional source control of urban and industrial runoff. An example of an incentives might be to provide rebates on construction permit fees when erosion control measures have been applied.

Expected Benefits: As noted earlier, source control measures have only a limited effect on the quality of urban runoff. Strong financial incentives for implementation of source control measures could produce similar reductions in stormwater runoff loads as shown for Action 18.

Other Considerations: It may be administratively difficult to develop a stormwater pollutant source control program based on financial incentives because determination of compliance is problematic in the absence of physical facilities. It may be most practical for erosion control at construction sites where inspectors on site for other purposes could check whether erosion control measures have been applied, and if so provide a rebate on construction permit fees.

Compatibility with On-going Programs: Action 19 is compatible with on-going programs both external and internal to CALFED. However, it is different in kind from the existing stormwater program established pursuant to the Clean Water Act and administered by the Regional Water Quality Control Board. The existing program relies on regulation rather than incentives.

Action 20. Reduce urban and industrial water quality parameters of concern loadings to the Delta and its tributaries through better planning of new developments to reduce urban and industrial runoff. Examples of better planning might include design of storm drainage systems that target maximum infiltration of stormwater into the ground or on-site or regional stormwater sedimentation facilities that detain the majority of stormwater for at least 8 hours.

Expected Benefits: Action 20 addresses new rather than existing urban and industrial development. As part of better planning, the following controls might be built into new development.

- Storm drainage systems will be designed to cause infiltration of stormwater into the ground to the maximum extent possible consistent with public and structural safety.
- On-site or regional stormwater sedimentation facilities will be built that detain 80 percent of stormwater for at least 8 hours.

The following removal rates are assumed for stormwater detained for 8 hour: total suspended solids, 65 percent; biochemical oxygen demand, 30 percent; ammonia and nitrate nitrogen, 25 percent; total copper, 50 percent; total zinc, 45 percent.

Action 20 will have no effect on pollutant emissions in stormwater from existing urban and industrial lands but will reduce the rate of increase in pollutant loads as development occurs.

Other Considerations: Building stormwater runoff controls into new development is easier than retrofitting existing developed areas. Space can be provided in new development for detention facilities and landscaped areas can be designed to maximize infiltration.

Compatibility with On-going Programs: Action 20 is compatible with on-going programs both external and internal to CALFED. It could best be implemented by building on the existing stormwater regulatory program established pursuant to the Clean Water Act and Administered by the Regional Water Quality Control Board. Most urban stormwater plans prepared for cities with a population of 100,000 or more include measures to reduce stormwater pollutants from new development.

Action 32A: Provide incentives for pesticide users to increase implementation of best management practices (BMPs) including integrated pest management (IPM) to reduce pesticide loads and concentrations to the Delta and its tributaries from urban & industrial runoff.

Expected Benefits: Action 32 would involve requiring public and private entities including homeowners to adopt integrated pest management practices. This may produce some reduction in pesticide content of urban runoff.

Other Considerations: It would be relatively simple to implement Action 32 if it primarily involves education and public information activities and the adoption of integrated pest management practices by public agencies.

Compatibility with On-going Programs: Action 20 is compatible with on-going programs both external and internal to CALFED. It could best be implemented by building on the existing stormwater regulatory program established pursuant to the Clean Water Act and Administered by the Regional Water Quality Control Board. Integrated pest management could be included as a best management practice in urban stormwater management plans. To be effective the existing program would have to be expanded to cover cities with a population of less than 100,000.

ATTACHMENT C

AGRICULTURAL DRAINAGE

Actions to Reduce Loadings/Concentrations of CALFED Water Quality Parameters of Concern due to Agricultural Drainage

REDUCTION IN PARAMETER OF CONCERN LOADINGS DUE TO AGRICULTURAL DRAINAGE
(Actions 1, 10, 11, 12, 13, 14, 15, 16, 32B)

Goal

The goal of these actions is to maintain or improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e. g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to reduce the loading and/or concentration of water quality parameters of concern attributable to AGRICULTURAL DRAINAGE within the Sacramento and San Joaquin river basins, Delta, and Suisun Marsh.

Geographic Scope

The geographic scope is defined as all of the following:

- areas within the Delta
- areas outside of the Delta in which biological resources that use the Delta are impacted
- areas outside of the Delta that are significant source areas for parameters of concern in the Delta

Thus, the Sacramento River above Red Bluff Diversion Dam would be in-scope with respect to the impact of metals concentrations and anadromous fish, but out of scope with respect to impacts on organisms unrelated to Delta biological resources. Also, Salt Slough is in-scope as a significant source of salt and trace element loading to the Delta.

Agricultural drainage sources within the geographic scope will be discussed in four categories:

1. **San Joaquin Valley subsurface drainage.** Includes subsurface drainage from lands south of the Delta whose subsurface drainage outlet is a tributary to the Delta.
2. **San Joaquin Valley surface drainage.** Includes surface drainage from lands south of the Delta whose surface drainage outlet is a tributary to the Delta.
3. **Delta drainage.** Includes surface and subsurface drainage from lands in the Delta.
4. **Sacramento Valley surface drainage.** Includes surface drainage from lands north of the Delta whose surface drainage outlet is a tributary to the Delta.

Parameters of Concern Attributable to Agricultural Drainage

- Boron
- Copper
- Selenium
- Carbofuran

- Chlorpyrifos
- Chlordane
- Diazinon
- DDT
- PCB
- Toxaphene
- Ammonia
- Bromide
- Chloride
- Sodium
- SAR
- Salinity
- Nitrate
- Pathogens
- pH
- TDS
- Turbidity
- TOC

Estimated Parameter of Concern Loadings Due to Agricultural Drainage

[Work in Progress]

When evaluating water quality, it is helpful to make a distinction between surface and subsurface drainage:

Surface drainage: During rainfall or irrigation, some proportion of water may run off of the land and enter surface drainage ditches and other water bodies. This runoff is surface drainage. Constituents of surface drainage may include substances dissolved in rain or irrigation water when it arrives to a field, plus substances dissolved in the water as it flows across the field, plus substances sorbed onto material (soil and surface litter) that becomes suspended in the flowing water. To varying degrees, ***pesticides and nutrients*** are sorbed onto solid materials. On Delta organic soils, organic material (***TOC***) can be suspended in runoff. The quality of surface drainage, therefore, depends largely on the amount of suspended material. To help identify surface drainage sources, it is useful to delineate the ***surface drainage area that flows to a water body***.

Subsurface drainage: To grow crops, some lands must be artificially drained to lower shallow groundwater levels. Shallow groundwater may seep into perforated drain pipes or intermittent field ditches, and flows to collection ditches and ultimately to other water bodies. Shallow groundwater contains dissolved constituents that may have migrated laterally to the area, that have been dissolved from local soil minerals, and that are applied with irrigation water. Solutes concentrate in shallow groundwater when plants are grown, since they generally absorb more water than solutes. Subsurface drainage water, therefore, can contain relatively high concentrations of ***dissolved trace elements, other salts, and organic compounds (TOC)***. These concentrations may become more problematic when subsurface drainage is stored and allowed to evapoconcentrate. To identify subsurface drainage sources, it is useful to identify areas meeting the following conditions:

- shallow groundwater within the not zone
- artificial subsurface drainage installed and functioning
- subsurface drainage conveyed to the water body in question
- constituent concentrations in shallow groundwater high relative to levels of concern

Loads of parameters of concern differ broadly among the four agricultural drainage source areas cited above. A general description follows, with more detailed data shown on Figures ___ and Tables ___. Also, Table 1 provides a list of potentially useful data resources that have been identified, most of which have not yet been fully exploited. The data presented here are preliminary and intended for discussion. **This is not a definitive description of agricultural drainage sources. Such a description will require much more intensive exploitation of existing data, and perhaps some new data development.**

1. **San Joaquin Valley subsurface drainage.** Naturally saline lands and geologic sources of trace elements, notably selenium, arsenic, and molybdenum, characterize some areas with artificial subsurface drainage in the San Joaquin Valley. Because of this, some of the subsurface drainage systems no longer discharge to water bodies tributary to the Delta. A Delta water quality data base was developed by the Agricultural Water Quality Subteam. Points for which data were collected (from existing DWR and USBR sources) are shown on Figure 1. Figure 2 shows the relative salt and selenium loads to and in the San Joaquin River at a number of points.

2. **San Joaquin Valley surface drainage.** Surface drainage from irrigated land within this area flows to the Delta, and to other water bodies within the geographic scope. Pesticide sources have not been mapped in detail as yet.

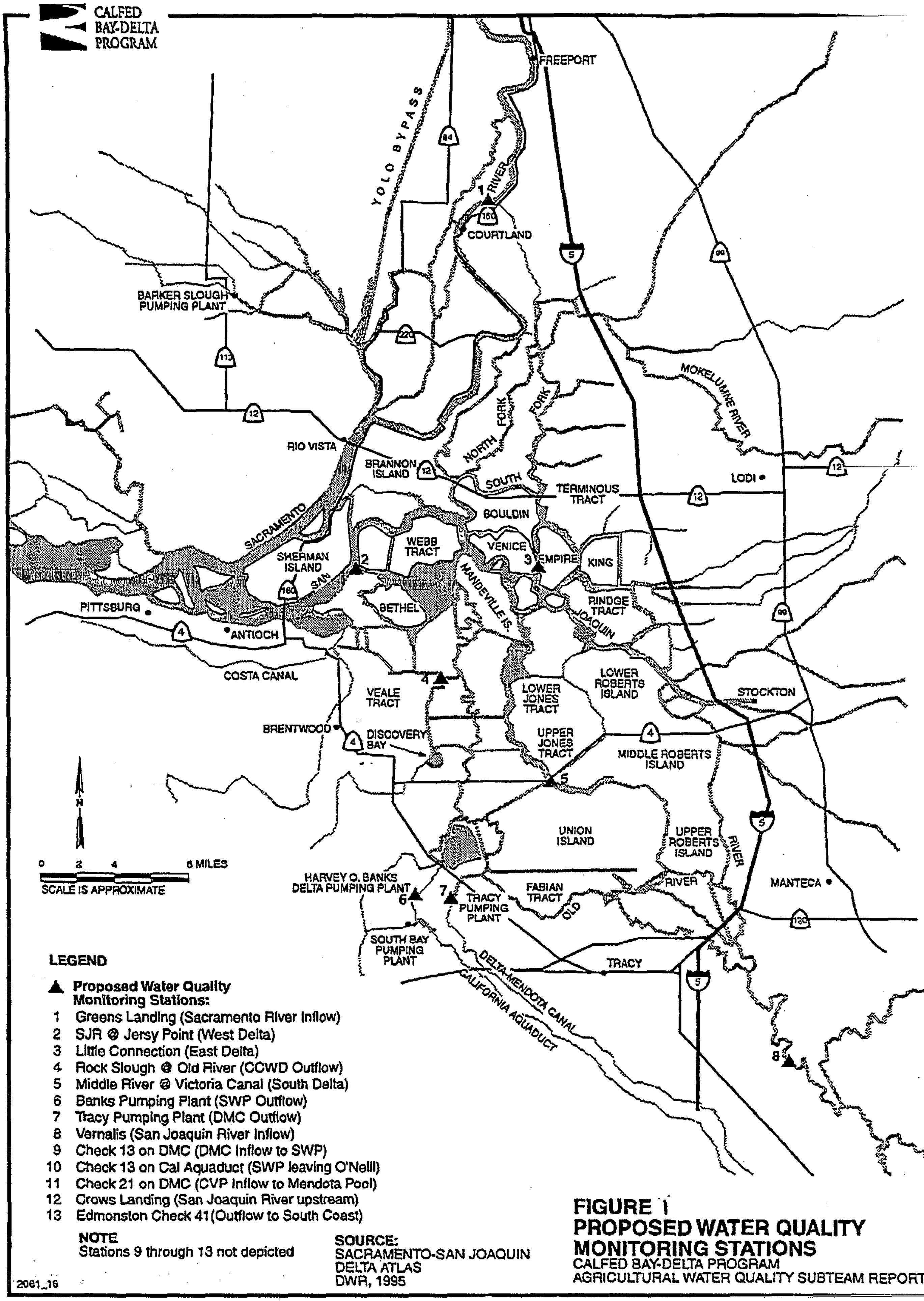
3. **Delta drainage.** Drainage outlets within the Delta are shown on Figure 3. Soils of the Delta can have high organic matter contents, resulting in elevated levels of TOC in drainage. Also, drainage volumes are considerable, due to the low elevation of irrigated lands, many below the level of adjacent water bodies.

4. **Sacramento Valley surface drainage.** Although considerable areas of the Sacramento Valley have relatively high groundwater, subsurface drainage is not widespread, and little attention has been given to characterizing its quality. However, surface drainage volumes are large, partly owing to the nearly 500,000 acres of rice that is flood irrigated in the area. Surface drainage is therefore the principal medium of loading to the Delta and other water bodies within the geographic scope. As with the San Joaquin Valley, pesticide sources have not been mapped in detail as yet. Existing source control programs in the Sacramento Valley will be discussed in the next section.

Water Quality Problem Areas for Parameters of Concern

[Work in Progress]

This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento and San Joaquin rivers will be identified.



LEGEND

▲ **Proposed Water Quality Monitoring Stations:**

1 Greens Landing (Sacramento River Inflow)
2 SJR @ Jersy Point (West Delta)
3 Little Connection (East Delta)
4 Rock Slough @ Old River (CCWD Outflow)
5 Middle River @ Victoria Canal (South Delta)
6 Banks Pumping Plant (SWP Outflow)
7 Tracy Pumping Plant (DMC Outflow)
8 Vernalis (San Joaquin River Inflow)
9 Check 13 on DMC (DMC Inflow to SWP)
10 Check 13 on Cal Aquaduct (SWP leaving O'Neill)
11 Check 21 on DMC (CVP Inflow to Mendota Pool)
12 Crows Landing (San Joaquin River upstream)
13 Edmonston Check 41 (Outflow to South Coast)

NOTE
Stations 9 through 13 not depicted

SOURCE:
SACRAMENTO-SAN JOAQUIN DELTA ATLAS
DWR, 1995

FIGURE 1
PROPOSED WATER QUALITY MONITORING STATIONS
CALFED BAY-DELTA PROGRAM
AGRICULTURAL WATER QUALITY SUBTEAM REPORT

2081_19

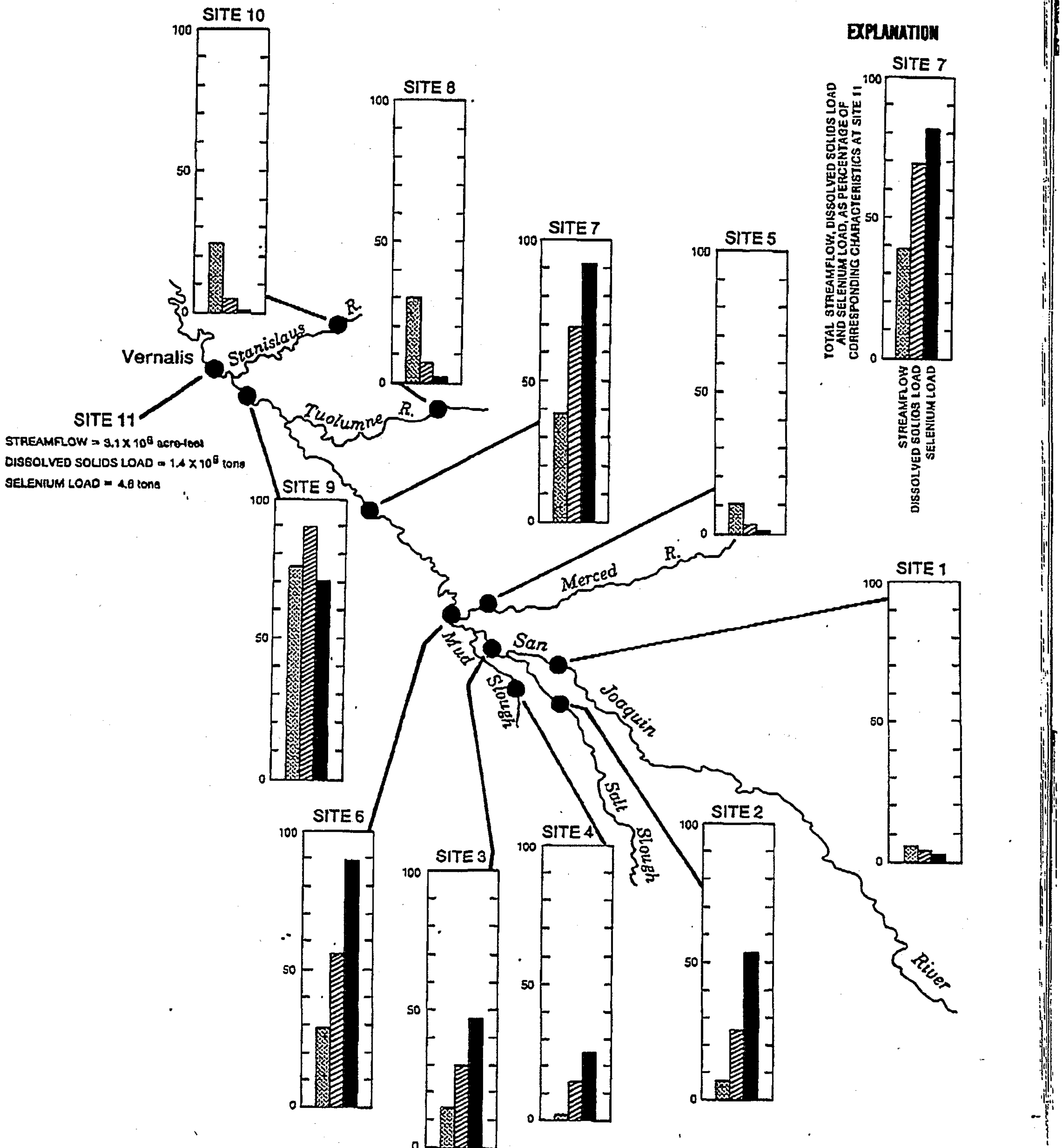
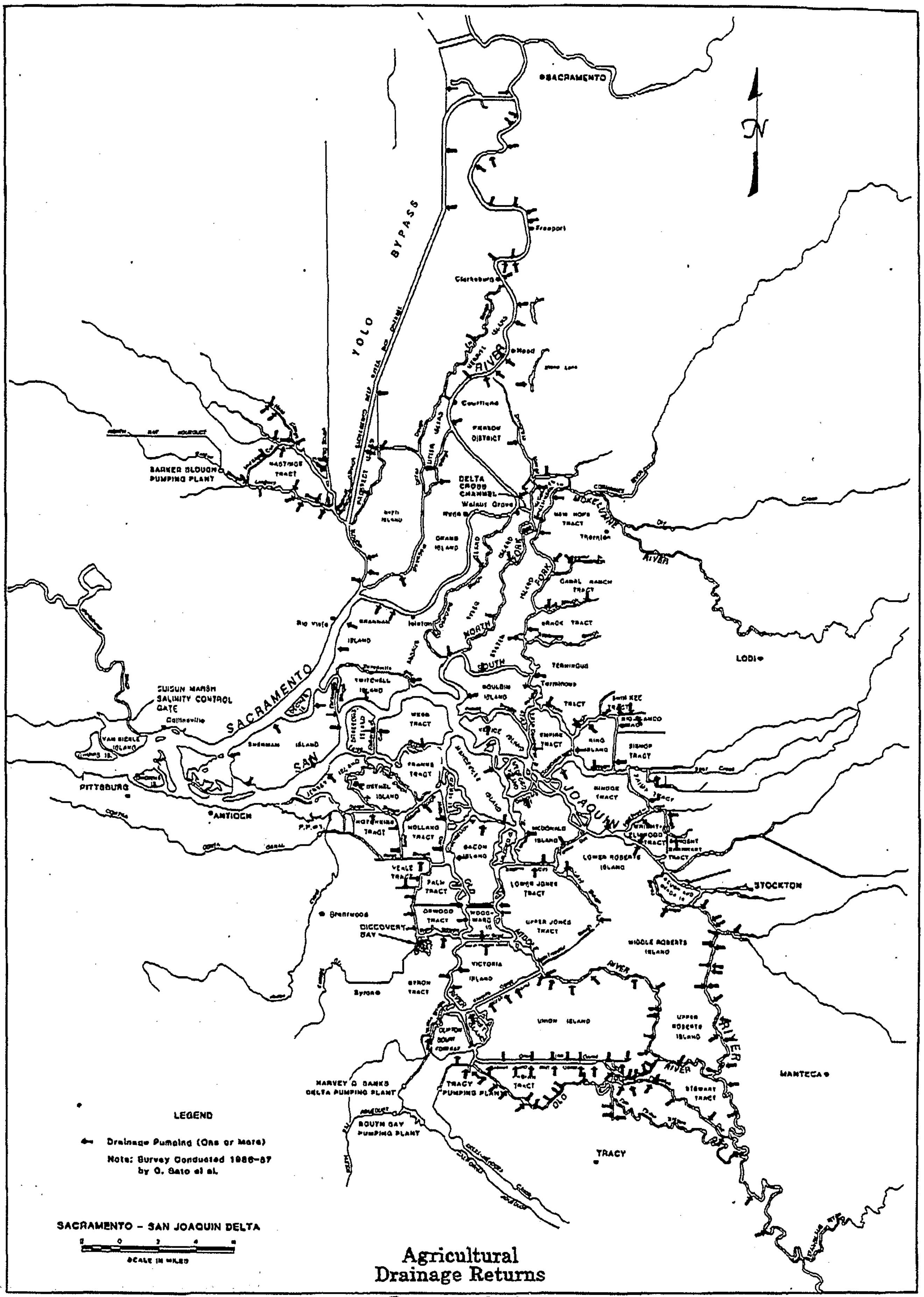


Figure 2

~~FIGURE 67~~.— Streamflow and loads of dissolved solids and dissolved selenium in the San Joaquin River during the low-flow period as percentages of those at site 11, near Vernalis. (See figure 65 for locational features.)

C-036989



Agricultural Drainage Returns

Sacramento–San Joaquin Delta Atlas FIGURE 3 *Department of Water Resources*

Current Programs

Two current programs will be discussed briefly:

The Drainage Reduction Program. Department of Water Resources: This program examined the potential of a number of technologies and management tools to reduce subsurface agricultural drainage. Examples include improved furrow irrigation, shallow groundwater management, tiered water pricing, irrigation efficiency, and emerging irrigation technologies. The Supplemental Information section provides a summary of funded projects.

The Rice Herbicide Program. Initiated by the California Department of Pest Regulation in 1984. The herbicides are not included among the parameters of concern, but this may be largely due to this program and the efforts made by the rice industry to reduce herbicide concentration in surface drainage. This program included establishment of rice herbicide performance goals for the Colusa Basin Drain and the Sacramento River. Holding times for rice irrigation water after herbicide application were specified, and the rice industry installed a variety of innovative irrigation return flow control systems.

Other programs, practices, and regulations that influence agricultural drainage water quality include the following:

- Federal and state restrictions on the use and handling of pesticides.
- Voluntary implementation of IPM and BMP's to reduce farming costs and pollution sources.

Other recommendations include those developed by a series of Technical Advisory Committees to the California State Water Resources Control Board, covering the following areas:

- Irrigated agriculture
- Pesticide management
- Dairy and feedlot management
- Rangeland management
- Fertilizer management

Effectiveness of Current Programs

The Drainage Reduction Program

[Work in Progress]

The Rice Herbicide Program. Resulting reductions in rice herbicide concentrations were dramatic, and generally in compliance with increasingly stringent performance goals. The program, context, and results are described in the Supplemental Information section.

Priority Actions to Reduce Impacts of Agricultural Drainage

Many upland crops are grown in intensive cropping systems in this area, and most employ some level of pesticide application.

Action 1: Control the timing of agricultural drainage to coincide with periods when dilution flow is sufficient to achieve CALFED water quality target concentrations.

Expected Benefits: Reductions in loadings of parameters of concern associated with agricultural drainage to waters within the geographic scope.

Other Considerations:

- This also implies temporary retention (storage) of drainage in source areas.
- Drainage from areas producing high concentrations of parameters of concern would be targeted. Subsurface drainage return flow with high selenium concentrations is one example.
- Coordinate effort with existing programs.
- Discharge from storage would be problematic in dry years, when periods of high flow would not occur.
- Discharge would be limited by Vernalis standards for water quality.
- Kesterson Reservoir was conceived for this purpose.

Action 11: Implement additional agricultural source control for water quality parameters of concern found in agricultural surface and sub-surface drainage. Implementation may include incentives and/or enforcement of existing regulations.

Expected Benefits: Reductions in loadings of parameters of concern associated with agricultural drainage to waters within the geographic scope.

Other Considerations:

- Surface and subsurface drainage mobilize different constituents, and must be treated separately. For example, pesticide and nutrient loads are principally in surface drainage, whereas salinity and trace elements (from west side San Joaquin Valley lands), and TOC (from in-Delta lands) are principally in subsurface drainage.
- Areas producing high concentrations of parameters of concern would be targeted. Subsurface drainage return flow with high selenium concentrations is one example.
- Implementation strategy should differ between parameters for which load is principal concern (salinity), relative to those for which concentrations are the principal concern (pesticides and trace elements).
- Concentrate on load, considering EWMP's when they can be cost-effectively related to load reduction. A reduction in drainage volume without reduction in load will result in higher concentrations. However, Ayers and Shrale (Irrigation efficiency and regional subsurface drain flow in the west side of the San Joaquin Valley, no date) reported that the total load of Selenium and Borion in drainage water was proportional to flow.
- Incentives or enforcement of existing regulations are included, although existing regulations appear to be adequately enforced.

- Source control could be effected by measures such as modification of field drainage systems; pest, irrigation, and tailwater management to reduce pesticide loads; BMP's to reduce pesticide loads; and water conservation where it does not conflict with sustainable production (e.g., on lands that have no drainage problem, but whose shallow groundwater flows to neighboring, drainage affected lands).
- Coordinate effort with existing programs.

Action 13: Provide incentives to fallow or retire land that is a major source of water quality parameters of concern. Landowner participation should be voluntary and by compensated purchase or lease payment.

Expected Benefits: Reductions in loadings of parameters of concern associated with agricultural drainage to waters within the geographic scope.

Other Considerations:
- Marginally productive land to be targeted as a matter of priority, since removal of this land from production would have the least impact on local socioeconomic conditions and would likely be more cost effective.
- Marginal benefit would be greater, marginal cost lower, for fallowing of land during drought years.
- Targeted parameters would be principally trace elements and TOC.
- Coordinate effort with existing programs.

Action 32B: Implement additional agricultural source control for water quality parameters of concern found in agricultural surface and sub-surface drainage. Implementation may include provision of incentives for pesticide users to increase implementation of best management practices (BMPs) including integrated pest management (IPM) to reduce pesticide loads and concentrations from agricultural drainage.

Expected Benefits: Reductions in loadings of pesticides of concern associated with agricultural drainage to waters within the geographic scope

Other Considerations:
- IPM technology is expensive to develop, therefore priority would be increased implementation of existing technology that reduces pesticide loading.
- Incentives might serve to help farmers transition into technologies that involve significant startup costs or risks.
- In the medium term, IPM could reduce production costs for some farms.
- Coordinate effort with existing programs.

Other Actions to Reduce Impacts of Agricultural Drainage

[Work in Progress]

Action 10: This action has been combined with Action 11.

Action 12: Improve source irrigation water quality in sub-surface drainage source areas. All things being equal, higher quality irrigation water will result in better quality drainage.

Expected Benefits: Reductions in loadings of salinity and trace elements associated with agricultural drainage to waters within the geographic scope.

Other Considerations:
- Due to its large volume, water quality for irrigation is highly constrained, so that programs to improve irrigation water quality might not be feasible.
- This action could be considered as a "no-action" alternative to actions that would result in significant degradation of irrigation water quality.

Action 14: Reduce the loadings of water quality parameters of concern entering the Delta and San Joaquin tributaries by concentrating and disposing of agricultural sub-surface drainage in evaporation ponds in the San Joaquin Valley.

Expected Benefits: Reductions in loadings of salinity and trace elements associated with agricultural drainage to waters within the geographic scope.

Other Considerations:
- Wildlife hazards are associated with concentrated subsurface drainage.
- Disposal of evaporite salts is environmentally problematic and costly.
- Construction and land costs of ponds are considerable.
- Concentrate effort in trace-element source areas.

Action 15: Reduce the loadings of water quality parameters of concern entering the Delta and its tributaries by treating agricultural surface drainage and/or Delta agricultural sub-surface drainage in constructed wetlands.

Expected Benefits:
- Reductions in loadings of TOC associated with Delta agricultural drainage.
- Reductions in pesticides concentrations in treated surface drainage.

Other Considerations:
- Reduction in TOC in Delta wetlands may or may not be feasible.
- Size and cost of constructed wetlands might have to be large to have the desired impact.

Action 16: Reduce the loadings of water quality parameters of concern entering the Delta and San Joaquin tributaries by treating a significant portion of San Joaquin agricultural sub-surface drainage by reverse osmosis or other means.

Expected Benefits:
- Reductions in loadings of salt and trace metals associated with agricultural drainage to waters within the geographic scope.
- Dilution flow available due to decreased diversion for irrigation.

Other Considerations:

- Treated water would likely be reused locally, but may or may not replace other water supply.
- Treatment by reverse osmosis or other means might not be cost effective.

Compatibility with On-Going Programs

- Water quality standards, e.g. Vernalis
- Water quality performance goals, e.g. Colusa Basin Drain
- Drainage Reduction Program
- SWRCB task force recommendations
- District drainage control programs

ATTACHMENT D

WATERSHED COORDINATION ACTIONS

Actions That Improve Water Quality Through Coordination With and/or Assistance to Local Watershed Management Programs or Other Efforts

CALFED/379

IMPROVEMENT OF WATER QUALITY THROUGH WATERSHED MANAGEMENT
(Actions 21, 29, 30, 31)

Goal

The goal of these actions is to maintain or improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e. g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to improve water quality (as defined by the parameters of concern listed below) within the Sacramento River and San Joaquin River Basins, Delta and Suisun Marsh through coordination with and /or assistance to local watershed management programs or other efforts.

Geographic Scope

All areas within Sacramento, San Joaquin, and Delta watersheds, with emphasis on waterways below major dams.

Parameters of Concern

- Cadmium
- Copper
- Mercury
- Selenium
- Zinc
- Carbofuran
- Chlorpyrifos
- Diazinon
- Ammonia
- Dissolved Oxygen
- Salinity
- Sodium
- Nitrate
- pH
- Temperature
- Total Dissolved Solids
- Total Organic Carbon
- Turbidity

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Estimated Loadings

[Work in Progress]

Water Quality Problem Areas for Parameters of Concern

[Work in Progress]

This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento, and San Joaquin rivers will be identified.

Current Programs

[Work in Progress]

A number of localized watershed management efforts are underway in the hydrologic basin which drains to the Delta. These efforts are motivated by a variety goals and objectives, including water quality protection, riparian habitat restoration, habitat management, fishery enhancement, water conservation, erosion control, wetlands protection, sustainable land use and development, and total resource management. Stakeholders in these efforts are similarly varied, including local landowners, community organizations, lumber companies, utility companies, corporations, local resource conservation districts, reclamation districts, irrigation districts, counties, cities, flood control agencies, state agencies (CDFG, DWR, RWQCB, DPR, CDF, SWRCB, CalTrans), federal agencies (USFS, NRCS, EPA, USFWS, ACE, BLM, USDA, BOR, DOT, FHA), The Nature Conservancy, The Audobon Society, California Waterfowl Association, Ducks Unlimited, California Trout, Inc., California Fly Fishermen, University of California, and UC Cooperative Extension.

The following is a brief description of watershed management efforts currently underway in the Sacramento Valley, San Joaquin Valley and Delta. This listing is not comprehensive

Sacramento River Watershed Programs

Name	Cache Creek
Location	Cache Creek Basin, Yolo County, Colusa County, Lake County, and Napa County (736,000 acres)
Description	Environmental restoration along creek, wetland habitat creation, water quality protection, control sediment loadings

Name	California Mallard Program
Location	Upper Stoney Creek, Glenn County, Colusa County, Tehama County (900 acres)
Description	Manage grazing operations to benefit upland nesting habitat for birds, restore riparian vegetation, protect water quality

Name	Laguna Creek and Deer Creek Watershed Study
Location	Laguna Creek and Deer Creek, Sacramento County (20,000 acres)
Description	Wetlands preservation and creation, water quality protection

Name	Morrison Creek Project
Location	Upper Morrison Creek, Cosumnes River, Sacramento County (15,000 acres)
Description	Preservation and creation of wetlands, resource management

Name	Reclamation District 1500 River Basin Plan
Location	Sutter County (68,000 acres)
Description	Water quality protection, water quantity issues, water conservation

Name	Sacramento River Project
Location	Sacramento River, Tehama County, Butte County, Glenn County, Colusa County (10,000 acres)
Description	Restore riparian habitat along 100 mile reach of river between Red Bluff and Colusa

Name	Sacramento River Watershed Program
Location	Entire Sacramento River drainage, numerous counties (16 million acres)
Description	Protect water quality, promote sustainable development, improve aquatic and riparian habitat, total resource management

Name	Yolo County Habitat Management Program
Location	Yolo County
Description	Multi-species habitat management and enhancement, sustainable agriculture, erosion control

Name	Hahn Road Watershed
Location	Sacramento River, Colusa Basin Drain, Colusa County
Description	Six water quality demonstration sites for reduction of nonpoint source pollutant loadings into Colusa Basin Drain

Name	Cow Creek CRMP
Location	Cow Creek, Shasta County (185,500 acres)
Description	Reduce fire hazard, improve riparian habitat, improve timber production

Name	Lassen Willow Creek Watershed Project
Location	Willow Creek, Lassen Creek, Modoc County (40,000 acres)
Description	Improve water quality and fish habitat

Name	Upper Pit River Watershed Project
Location	Upper Pit River, Modoc County (359,000 acres)
Description	Resource management to control soil erosion, protect water quality, sustain agricultural, recreational and rural activities

Name	Lassen Watershed Project - Mill Creek
Location	Mill Creek, Tehama County (85,800 acres)
Description	Erosion control, fisheries protection, water quality protection, riparian habitat protection, sustainable land use and development

Name	Big Chico Creek Watershed Project
Location	Big Chico Creek, Butte County and Tehama County
Description	Fisheries protection, water quality protection, riparian habitat protection

Name	Deer Creek Watershed Project
Location	Deer Creek, Tehama County
Description	Fisheries protection, sustainable land uses and economy, habitat protection, land stewardship

San Joaquin River Watershed Programs

Name	Selenium Total Maximum Monthly Load (TMML) for San Joaquin River
Location	Grasslands watershed (south of Mendota)
Description	Agricultural stakeholders participated in the development of a TMML for selenium discharges to the San Joaquin River. This TMML will be administered by the Central Valley Regional Board as part of its recently adopted Basin Plan. This is an ongoing program to work with stakeholders to meet selenium waste discharge requirements

Name	San Joaquin River National Water Quality Assessment (NAWQA) Program
Location	San Joaquin River and tributaries
Description	This three-year sampling effort was conducted by the U.S. Geological Survey between 1991 and 1994, including physical, chemical, and biological monitoring of surface and ground waters within the San Joaquin River system. Sampling stations were located on the San Joaquin River, the Merced, Stanislaus, and Tuolumne Rivers, and in Mud and Salt Sloughs, Orestimba Creek, and Turlock Irrigation Drain Lateral No. 5. USGS staff are currently compiling and analyzing the results of the sampling efforts

Name	Stanislaus Work Group
Location	Stanislaus River
Description	Developing interim and long term watershed management approaches for the Stanislaus River watershed in order to meet salinity water quality objectives at Vernalis. Interim approach (for years 1997-98) currently being finalized. (I believe Bureau of Reclamation is involved/overseeing these efforts

Name Panoche/Silver Creek Coordinated Resource Management and Planning (CRMP)
Location Panoche Creek, Silver Creek, San Joaquin River
Description Cooperative effort of 18+ agencies/organizations and 20+ private landowners to reduce flooding and selenium contamination along Panoche Creek and the City of Mendota, and to improve the riparian condition of the watershed. Addresses agriculture, erosion control, grazing, mining, riparian, and other resource management issues.

Name Dormant Spray Pesticide Management Efforts
Location San Joaquin Valley
Description Department of Pesticide Regulation efforts to develop management programs/BMPs for dormant crop pesticide sprays containing diazinon and chlorpyrifos

Name Salinity Management Program for San Joaquin River
Location San Joaquin River (primarily westside dischargers)
Description Central Valley Regional Board in the early stages of initiating a stakeholder-based effort aimed at meeting salinity water quality objectives at Vernalis

Other Small-Scale related efforts:

- Tuolumne River Salmon Habitat Enhancement - Ruddy Project
- Root Creek Study
- Magneson Pond Isolation and Stream Habitat Modification

Delta Watershed Programs

[Work in Progress]

Effectiveness of Current Programs

It is premature to judge the effectiveness of many of the ongoing efforts on Delta water quality and ecosystem integrity. Most programs have been effective in the recruitment of stakeholders, mobilization of local interests and the development of community awareness around specific issues.

Priority Actions to Improve Water Quality

Action 21: Promote and support efforts of local watershed programs that improve water quality parameters of concern within the Delta and Delta tributary watersheds. Efforts may include coordination, incentives, and/or other assistance.

Expected Benefits. Benefits include local project support, interest-based solutions to conflicts, greatly expanded information base available through monitoring and data management activities common to most programs which will lead to better decision-making in the long term, greatly expanded public outreach and education possibilities, increased efficiency at all levels through coordination, collaboration and elimination of redundancies.

Other Considerations. Problem identification and solution is slower but potentially more durable with the watershed approach; most approaches rely heavily on consensus driven solutions and voluntary participation in problem solving; coordination will require diligence and adequate funding.

Compatibility with On-going Programs.

Actions 29 and 30 -Improve water quality parameters of concern within the Delta and its tributaries by restoring or improving riparian habitat.

Expected Benefits. Benefits include an improved ecosystem, reduction of significant ecosystem stresses, and improved conditions for species of concern.

Other Considerations. Improvements will be gradual. Action will not be successful in isolation, they must be an element of a comprehensive watershed approach.

Compatibility with On-going Programs.

[Work in Progress]

Action 31: Identify and implement actions to address potential toxicity to water and sediment within the Delta and its tributaries by conducting toxicity testing and toxicity identification evaluations and/or other appropriate methods. Coordinate these efforts with other programs.

Expected Benefits. Benefits include better understanding of ambient conditions and of toxic stressors, improved ability to focus solutions on significant problem areas, and improved ability to communicate the need for solutions.

Other Considerations. This action must be part of an overall information collection effort to improve the understanding of factors influencing water quality and associated beneficial uses. There may be an opportunity to utilize or contribute to ongoing or planned efforts under existing watershed programs.

Compatibility with On-going Programs.

[Work in Progress]

References:

[Work in Progress]

Conversation with Joseph Domagalski at USGS

Conversation with Kathy Freas, CH2M HILL - 12/3/96

Conversation with Joe Karkoski, EPA assigned to State Board - 12/3/96

Conversation with Jerry Bruns, Central Valley Regional Board

WASTEWATER & INDUSTRIAL DISCHARGES ACTIONS

Actions to Reduce Loadings/Concentrations of CALFED Water Quality Parameters of Concern due to Wastewater & Industrial Discharges

REDUCTION OF MUNICIPAL AND INDUSTRIAL WASTE DISCHARGES TO THE DELTA

(Actions 23, 24, 25 & 27)

Goal

The goal of these actions is to maintain and improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e.g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to reduce the loading and/or concentration of parameters of concern attributable to municipal and industrial dischargers within the Sacramento and San Joaquin river bains, Delta, and Suisun Marsh.

Geographic Scope

The geographic scope is defined as all of the following:

- areas within the Delta
- areas outside of the Delta in which biological resources that use the Delta are impacted
- areas outside of the Delta that are significant source areas for parameters of concern in the Delta

Thus, the Sacramento River above Red Bluff Diversion Dam would be in-scope with respect to the impact of metals concentrations and anadromous fish, but out of scope with respect to impacts on organisms unrelated to Delta biological resources. Also, Salt Slough is in-scope as a significant source of salt and trace element loading to the Delta.

Targeted Parameters of Concern Attributable to Municipal and Industrial Discharges

- Cadmium
- Copper
- Zinc
- Mercury
- Chlorpyrifos
- Diazinon
- Ammonia
- Dissolved Oxygen
- Nutrients (Nitrate)
- Pathogens
- Salinity (TDS)
- Turbidity
- Temperature

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- Unknown Toxicity

Estimated Parameter Loading Due to Municipal and Industrial Discharges

[Work in Progress]

- Sacramento Regional
- West Sacramento
- Stockton
- Tracy
- Modesto
- Redding
- Red Bluff

Water Quality Problem Areas for Parameters of Concern

[Work in Progress]

This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento and San Joaquin rivers will be identified.

Current Programs

[Work in Progress]

There are current programs through the Regional Water Quality Control Boards and the Coast Guard to regulate and control discharges.

Effectiveness of Current Programs

[Work in Progress]

The effectiveness of the current RWQCB programs at limiting loadings of municipal discharges to the Delta is thought to be very high. However, the effectiveness of the programs to control boat discharges is unknown.

Priority Actions to Reduce Impacts of Municipal and Industrial Discharges

Action 23: Control discharges of domestic wastes from boats within the Delta and its tributaries by more extensive enforcement of existing regulations.

<u>Expected Benefits:</u> The main benefit will be the reduction in pathogen loading from point source discharges near water supply intakes and in recreational areas.

Other Considerations: It is unknown what impact the current discharges have on water quality. The method of implementing this action might be to provide additional boats and manpower to carry out enforcement and educational activities.

Other Actions to Reduce Impacts of Municipal and Industrial Discharges

[Work in Progress]

Action 24: Reduce water quality parameters of concern loadings to the Delta and its tributaries by treating a portion of upstream municipal wastewater effluent in wetlands.

Expected Benefits: Wetlands that treat domestic wastewater have been demonstrated to reduce metals and nutrients in the discharge.

Other Considerations: Wetlands treatment may increase the concentration to Total Organic Carbon (TOC) in the effluent. From a practical standpoint this action will only apply to those dischargers on the Sacramento River including Sacramento Regional, West Sacramento, and Stockton and Tracy in the southern Delta. Wetlands may concentrate parameters of concern.

Action 25: Reduce point source water quality parameters of concern loadings to the Delta and its tributaries through cost effective control of industrial and municipal wastewater discharges. Methods may include encouragement of pollutant credit trading.

Expected Benefits: The major benefit that is expected from this program is the reduction in metals from other discharges such as mines.

Other Considerations: The California Association of Sanitation Agencies (CASA) has a position paper in favor of pollution credit trading, and has developed a proposed program.

Action 27: Reduce point source water parameters of concern loadings to the Delta and its tributaries through control of industrial and municipal wastewater discharges. Methods may include incentives for reclamation and reuse.

Expected Benefits: Under this program there would be a percentage reduction in pollutant loading equal to the amount of reclaimed water used.

Other Considerations: From a practical standpoint this action would apply only to those dischargers on the Sacramento River including Sacramento Regional, West Sacramento, and Stockton and Tracy in the southern Delta. This action could also reduce the amount of water withdrawn from the system at those locations by replacing the amount of treated water used for uses replaced by reclamation.

Compatibility With On-Going Programs

It is the stated policy of the State of California that both the elimination of boat discharges, and the reduction of pollutant loading are goals. Water reclamation is a long term goal in California.

ATTACHMENT E

WATER TREATMENT ACTIONS

Actions to Improve Domestic Water Treatment Facilities

IMPROVEMENTS TO DOMESTIC WATER TREATMENT FACILITIES
(Actions 26, 28A, 28B)

Goal

The goal of these actions is to maintain and improve water quality in the Sacramento-San Joaquin Delta (Delta) to protect domestic water supplies as a beneficial use.

Objective

The objective of these actions is to improve water treatment technology and to improve source water quality conditions in the Delta.

Geographic Scope

The water utilities that will be considering improvements to their treatment technology range throughout the State and Federal water project area in Alameda, Contra Costa, Napa, Solano, Santa Clara, San Joaquin, Fresno, Kings, Kern, Los Angeles, Ventura, Orange, Riverside, San Bernardino, and San Diego Counties. The areas where improvement to source water quality are desired are in the Delta, primarily at or near the North Bay Aqueduct, Rock Slough, Mallard Slough, Old River, Clifton Court Forebay, and the Tracy Pumping Plant.

Parameters of Concern to Domestic Water Agencies

- Bromide
- Nutrients (Nitrate)
- Total Organic Carbon
- Pathogens
- Salinity (TDS)
- Turbidity

Estimated Parameters of Concern Loadings to Domestic Water Utility Intakes

[Work in Progress]

Water Quality Problem Areas for Parameters of Concern

[Work in Progress]

The two major problem constituents are Total Organic Carbon (TOC) and bromide. TOC is a potential problem when it is above 2 mg/L, and a major problem when it is above 4 mg/L. Bromide is a minor problem when it is above 50 ppb, and a major problem when it is above 150 ppb.

Water supply intake areas within the Sacramento-San Joaquin Delta are the primary areas of concern.

This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento and San Joaquin river basins will be identified.

Current Programs

[Work in Progress]

Currently, numerous water agencies are evaluating ways to upgrade their treatment facilities as detailed in Actions 26 and 28 below. There are no current operational programs to improve source water quality near intakes.

Effectiveness of Current Programs

[Work in Progress]

Water quality has improved in those water utilities that have undertaken improvements to treatment technology.

Priority Actions to Improve Domestic Water Quality

No actions where identified as Priority Actions for this goal.

Other Actions to Improve Domestic Water Quality

Action 26: Reduce the formation of disinfection by-products, and their concentration in the domestic water supply, resulting from the use of chlorine in water treatment plants. Conversion of facilities from chlorine to ozone would serve to reduce the formation of disinfection by-products.

Expected Benefits: The use of ozone versus chlorine, as a primary disinfectant, would reduce the formation and concentration of disinfection by-products.

Other Considerations: Elevated bromide concentrations as a result of sea water intrusion would present a problem with the use of ozone because of the formation of bromate.

Action 28A: Improve treated drinking water quality parameters of concern by providing incentives for the addition of enhanced coagulation, ozone, granular activated carbon filtration and/or membrane filtration facilities to the water systems treating water from the Delta.

Expected Benefits: These potential changes to treatment facilities will improve drinking water quality.

Other Considerations: Some existing facilities may not be able to retrofit would these technologies because of the age, location and configuration of the water treatment plants.

Action 28B: Improve source water quality parameters of concern at domestic water supply intakes, as identified in the geographic scope, by reducing Delta Island discharges that are high in TOC or other compounds that impact source water quality, or by relocating water supply intakes to areas that are not influenced by those discharges.

Expected Benefits: Improvement in source water quality will improve treated drinking water quality and lower the cost of treatment.

Other Considerations: Reducing Delta Island discharges may have an adverse impact on Delta agriculture.

Compatibility With On-Going Programs

Improvements to drinking water treatment plant technology will not impact other programs in the Delta, but will have a cost impact on domestic water users. Reduction of Delta Island discharges or relocation of water supply intakes may have an adverse impact on Delta agriculture that could require mitigation.

ATTACHMENT F

DILUTION ACTIONS

Actions That Use Dilution to Reduce the Concentration of CALFED Water Quality Parameters of Concern

CALFED/382

REDUCTION IN PARAMETER OF CONCERN CONCENTRATIONS TO THE SAN JOAQUIN RIVER BY THE ADDITION OF DILUTION WATER
(Actions 2, 3, 4, 5, 6, 7)

Goal

The goal of these actions is to maintain or improve water quality in the Sacramento-San Joaquin Delta (Delta) so that all beneficial uses are protected (e.g. municipal, industrial and agricultural water supply, recreation, fish and wildlife).

Objective

The objective of these actions is to reduce the concentration of water quality parameters of concern by the addition of dilution water from one or more sources to the San Joaquin River.

Geographic Scope

The area for these actions is primarily the San Joaquin River watershed area. These actions are designed to reduce the concentration of water quality parameters of concern entering the Delta and its tributaries from the San Joaquin Valley during low flow periods by acquiring dilution water (50,000 to 100,000 acre feet).

Parameters of Concern

- Boron
- Selenium
- Carbofuran
- Chlorpyrifos
- Diazinon
- Bromide
- Chloride
- Sodium
- SAR
- Salinity
- Nutrients (Nitrate)
- pH
- TDS

Estimated Parameter of Concern Loadings

[Work in Progress]

Water Quality Problem Areas for Parameters of Concern

[Work in Progress]

The main problem area is in the San Joaquin River from Vernalis downstream to the Delta. This section will include a comparison of water quality parameter target ranges and measured levels of parameters. Exceedences of target ranges that occur within the Delta, Sacramento, and San Joaquin rivers will be identified.

Current Programs

[Work in Progress]

Currently there are no dilution water addition programs in this watershed.

Effectiveness of Current Programs

[Work in Progress]

Dilution Actions to Reduce the Impacts of Targeted Parameters of Concern

No actions were identified as priority actions for this goal.

Other Dilution Actions to Reduce Impacts of Targeted Parameters of Concern

Action 2: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) from willing sellers. Action is primarily targeted at the San Joaquin River.

<u>Expected Benefits:</u> The benefit and this action would be to provide dilution water to the San Joaquin River during low flow periods to improve the water quality in the lower San Joaquin River and the Delta.

<u>Other Considerations:</u> Presumably the original use for this water would either have to be eliminated or a supplemental water source supply found.

Action 3: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet). Water would be acquired by providing incentives for more efficient water management of dams, including reservoir re-operation. Action is primarily target primarily at the San Joaquin River.

<u>Expected Benefits:</u> This action would have the same expected benefits as Action 2.

<u>Other Considerations:</u> Presumably the best opportunities for this option would be from those reservoirs on streams tributary to the San Joaquin River.

Action 4: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) through urban water conservation. Action is primary targeted at the San Joaquin River. Conservation might be achieved through use of incentives for implementation of best management practices by more suppliers and water users. Implementation of the action may reduce demand for existing water and may make dilution water available (including transfers), especially on the San Joaquin River.

Expected Benefits: This action would have the same expected benefits as Actions 2 and 3.

Other Considerations: The water utilities that may be subject to this option could either be existing State or Federal water project contractors or other utilities that take water directly from the system. An example of implementing this action may include water conservation in the Sacramento to provide water for transfer to the San Joaquin River.

Action 5: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring dilution water (50,000 to 100,000 acre-feet) through greater use of reclaimed wastewater. Action is primarily targeted at the San Joaquin River. Reclamation projects could include: recharge groundwater, use for agricultural irrigation, recycling and treating for potable or non-potable urban, use of grey water, and storage for use in meeting X2 standards. Reclamation programs would focus on facilities that currently discharge treated wastewater to salt sinks or other degraded bodies of water that are not reusable.

Expected Benefits: This action would have the same expected benefits as Actions 2, 3, and 4..

Other Considerations: The greatest opportunity for reclamation in State and Federal water project areas is probably in the Sacramento metropolitan and San Francisco Bay areas.

Action 6: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries by treating agricultural drainage and releasing it during periods of low flow for dilution purposes.

Expected Benefits:
- Dilution to reduce concentrations of parameters of concern.
- Removal of parameters of concern loads from a portion of agricultural drainage.

Other Considerations:
- Treatment of agricultural drainage for removal of principal parameters of concern has not been demonstrated.
- Potential for removal of pesticides by "in-field treatment" has been demonstrated for the special case of rice, which provides something like wetlands treatment.

Action 7: Reduce the concentration of water quality parameters of concern entering the Delta and its tributaries during low flow periods by acquiring additional dilution water through enhanced seasonal recharge and development of additional groundwater supplies. Water would be used for dilution, especially on the San Joaquin River.

Expected Benefits: This action would have the same expected benefits as Actions 2, 3, 4, and 5.

Other Considerations: One of the candidate areas for development of additional groundwater supplies may include the Sacramento Valley. Discharge of ground water to the Sacramento River for later diversion into the Delta Mendota Canal and release to the Mendota Pool is an example.

Compatibility With On-Going Programs

[Work in Progress]

Provision of "new" water for dilution in the San Joaquin River will impact one or more of the existing water users, and it may conflict with existing uses.

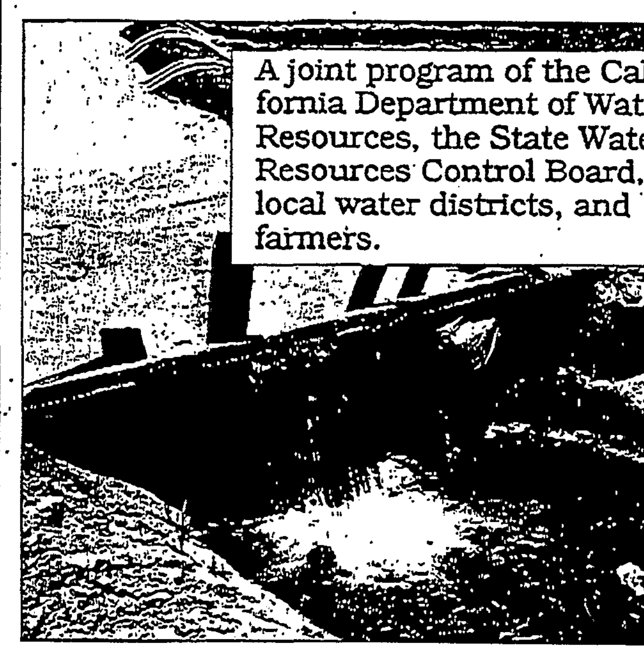
SUPPLEMENTAL INFORMATION

Appendix N

w.r. area
NPS file

Agricultural Drainage Reduction Program

Helping farmers to reduce drainage



A joint program of the California Department of Water Resources, the State Water Resources Control Board, local water districts, and farmers.

June 1989

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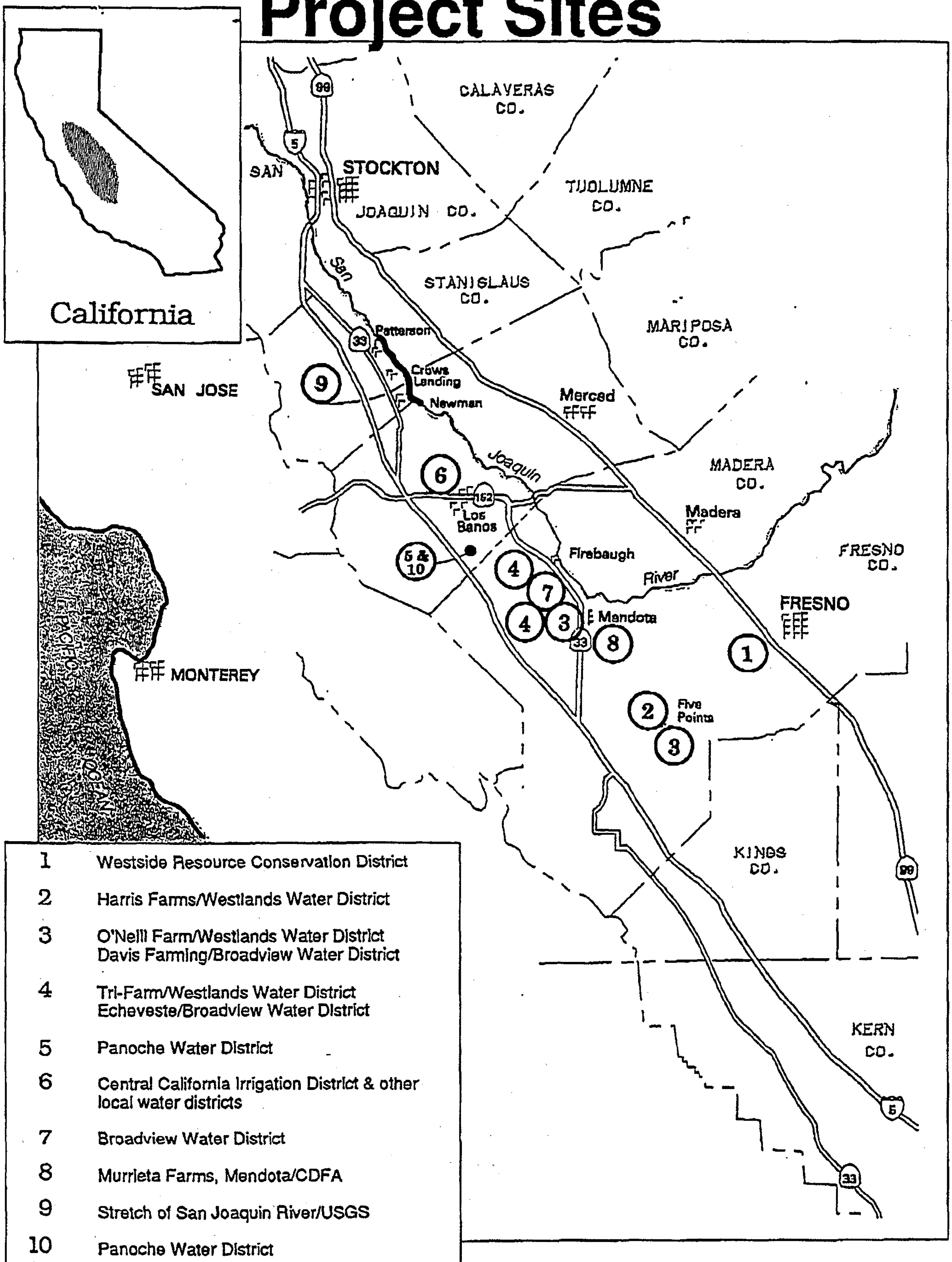
2525 Airpark Drive
P.O. Box 492478
Redding, CA 96049

Project Sites



Westside RCD Program

1

WESTSIDE RESOURCE CONSERVATION DISTRICT This on-farm cost-sharing implementation program is helping participating growers evaluate their existing irrigation systems and irrigation management practices. Based on each evaluation, recommendations for scheduling and irrigation management improvement are provided. The program is operated in cooperation with Westlands Water District.

Location
Westlands Water District

Contractor
Westside Resource Conservation District

Cost
$310,000 per year: $110,000 cost to the State & $200,000 from the WRCD; cooperating growers contribute an additional sum of about $300,000

Specifically, the program performs the following tasks:

- Field assessment prior to pre-irrigation;
- Pre-irrigation evaluation;
- Post-planting irrigation evaluation; and
- Production of a final report.

With each task, a report is given to the grower with recommendations. Irrigation scheduling is provided to the grower throughout the irrigation season. Scheduling reports are given to the grower in a timely manner so recommendations can be incorporated into subsequent irrigation events.

2 Emerging Irrigation Technology

This on-farm project is demonstrating emerging irrigation technologies to reduce applied water and drainage.

Location
Harris Farms
Westlands Water District

Contractor
Boyle Engineering

Cost
$300,000 over three years

Four irrigation systems are being tested. These are:

- A 40-acre low-energy precision application (LEPA) irrigation system;
- A 40-acre subsurface drip irrigation system;
- A 40-acre furrow system with improved management of timing and amount of the irrigation; and
- A 40-acre furrow system managed according to prevailing irrigation practices.

This project is monitoring:

- Quantity and quality of irrigation water applied and resulting drainage flows;
- Quality of ground water and ground water elevations; and
- Soil salinity, soil moisture, and crop yield.

The results of this study will form the basis for recommendations on system performance and irrigation management to reduce water use and drainage flows.

C-037021

Improved Furrow Irrigation 3

This on-farm project demonstrates how to reduce applied irrigation water and to increase irrigation efficiency and distribution uniformity while maintaining or increasing yield levels. This is done by applying advanced technology, innovative concepts, and automation systems to furrow irrigation management.

Location
O'Neill Farm
Westlands Water District

Davis Farming
Broadview Water District

(Each field is 160 acres)

Contractor
Dellavalle Laboratory, Inc.

Cost
$253,300 over three years

At the O'Neill Farm, controlled volume-level furrows technology and irrigation management are being used with the following concepts:

- Laser-leveled zero slope furrows;
- Center-fed furrows and short furrows;
- Pressure control systems;
- Automated shut-off of the irrigation system; and
- Automatic set changes.

At Davis Farming, surge flow/torpedo technology and irrigation management are being used with the following concepts:

- Short furrows and gated pipe;
- Run-off feedback and tail water management; and
- Automated set changes and soil moisture monitoring.

For both fields, quantity and quality of irrigation and drainage water, water table, run-off, soil moisture, and soil salinity are being monitored. Results of this study will be used to develop recommendations for improved management of furrow irrigation systems.

4 Shallow Ground Water Management

These two 160-acre-field on-farm studies have been designed to monitor and manage shallow ground elevation for two reasons. One is to control the water table as a viable source of moisture for crop evapotranspiration demand. The other is to differentiate the shallow portion of ground water (less in total dissolved salts and selenium) from the deeper portion (with relatively higher total dissolved salts and selenium).

Location
Tri-Farm
Westlands Water District

Echeveste
Broadview Water District
(Will start at the end of 1989)

Contractor
JMLord, Inc.

Cost
$175,000 over three years

At Echeveste, a new drainage system with relatively shallower drain depths will be installed. The plan is to differentiate and drain the upper layer of shallow ground water, which is lower in salinity and selenium.

At Tri-Farm, the existing tile drain will be modified by installing flow-control valves. The valves will allow the lowering or raising of the water table by closing or opening the valves respectively. This practice may allow use of ground water by crops since the water table can be managed at the root zone. For both fields, extensive work includes:

- Monitoring irrigations and evaluating irrigation distribution uniformity and irrigation efficiency;
- Monitoring quantity and quality of irrigation water, drainage flows, tail water, and run-off;
- Monitoring shallow ground water depth, fluctuation, and quality;
- Monitoring salinity, selenium, boron, and molybdenum in irrigation and drainage flows as well as in shallow ground water;
- Monitoring soil salinity and soil moisture status; and
- Monitoring crop yield and quality.

For both fields, data will be compared with the historical data on quality and quantity of water use and drainage flows. Recommendations will be made on the feasibility and economics of such systems.

Irrigation Efficiency & Regional Subsurface Drainage Flows

5

This study is designed to identify relationships among irrigation efficiency, drainage volumes, land elevation, crop type, and soil type. The study will identify geographic areas where irrigation management improvement and technology transfer can reduce drainage within and outside of the district.

Location
Panoche Water District

Contractor
Panoche Water District in cooperation with the U.S. Department of Agriculture/ Agricultural Research Service

Cost
$171,000 over three years

The on-farm study is being conducted over the entire area of the water district to:

- Identify relationships among irrigation efficiency, drainage volumes, land elevation, crop type, and soil type;
- Identify drainage water originated on-farm versus lateral subsurface flow originating upslope;
- Correlate drain flows with irrigation or rainfall events both within and upslope of the study area; and
- Model the water balance for the region studied based on the knowledge of crop, soil, irrigation efficiency, water use, drain flows, and hydraulic gradients for lateral ground water flow.

Quality and quantity of the irrigation and drainage water are also being monitored.

6 Water Conservation Coordinator

This project involves developing, coordinating, and implementing on-farm water conservation programs for eight irrigation districts in the San Joaquin Valley drainage problem area.

Location
Central California Irrigation District, Broadview Water District, Firebaugh Canal Water District, Grassland Water District, Panoche Drainage District, Panoche Water District, San Luis Canal, and San Luis Water District

Contractor
Central California Irrigation District

Cost
$225,000 over three years

The water conservation coordinator is developing both educational and implementation programs to help growers improve their irrigation management practices. The programs will be implemented according to the specific needs of each district.

Educational activities consist of:

- A newsletter, *The New Irrigator*, that is being mailed to the growers in the area. This newsletter addresses important soil-water-crop-production relationships, efficient irrigation practices, when to irrigate, how much water to apply, and how to modify irrigation practices; and
- Seminars that are tailored to improving water conservation methods for the specific needs of each district based on their irrigation systems, crops, and soils.

Implementation programs include:

- Close work and cooperation between the districts and growers on water conservation measures such as tail water re-use systems, use of gated pipes, use of soil moisture information to determine when to irrigate and how much water to apply, and improvements of existing irrigation systems.

Tiered-Block Water Pricing 7

The objective of this study is to test the effectiveness of tiered-block water pricing in reducing irrigation water use without reducing the crop yield.

Based on the crop and soil of the grower, certain seasonal water use is priced at a fixed rate. If a grower uses more than the predetermined amount of water, he must pay a much higher rate for each extra unit of water. This method does not limit the water supply to the grower but requires the grower to pay for use of excess water.

Location
Broadview Water District

Contractor
Broadview Water District

Cost
$50,000 over two years

Broadview Water District is assembling baseline data on the district's historic water use and drainage flow by crop.

The water district researchers are monitoring crop water use and drainage water quality and quantity for the 1989 irrigation season under:

- The regular pricing system; and
- A tiered-block water pricing method with a 250-percent higher price than the regular pricing system for water used in excess of crop need.

The results of this study will determine the effectiveness of tiered-block water pricing on reducing the amount of water applied.

8 Agroforestry

The feasibility of agroforestry (eucalyptus trees and atriplex plants) to reduce saline drainage and to lower the water table is being studied. In this study, drainage water from a 28-acre eucalyptus plot is being used to irrigate atriplex plants.

Location
Murrieta Farms, Mendota

Contractor
California Department of Food and Agriculture

Cost
$93,863 over three years

The California Department of Food and Agriculture is:

- Conducting water and salt balance studies in 28-acres of eucalyptus and 5-acres of atriplex plants;
- Estimating the actual evapotranspiration;
- Monitoring irrigation quantity and quality;
- Monitoring subsurface flows of water and salt; and
- Assessing overall water and salt balance in the experimental sites taking into account surface water inputs, lateral inflows and outflows, surface run-off, evapotranspiration, tile drainage, rise or fall of shallow ground water, and changes in soil water content.

Ground Water Contribution to the San Joaquin River 9

It is believed the San Joaquin River is the major source of total dissolved solids, boron, selenium, and other constituent loading to the southern Delta portion of the Bay-Delta Estuary. However, there is no agreement regarding the magnitude and quality of subsurface water that eventually seeps downslope and ends up in the San Joaquin River.

Although this project does not specifically address agricultural drainage, it has been designed to estimate magnitude and quality of ground water flows to the river and to develop a two-dimensional cross-section model.

Location
A 19-mile-long reach of the river stretching from the town of Patterson through Crows Landing to Newman

Contractor
United States Geological Survey (USGS)

Cost
$140,000 over two years

The USGS is conducting data collection and analysis. The project activities include:

- △ Installation of observation wells to a depth of up to 100 feet at Patterson, Crows Landing, and Newman;
- △ Collection of data on water table elevation, soil type, hydraulic conductivity, hydraulic gradient, river stage, and channel geometry;
- △ Monitoring ground water for comprehensive inorganic chemicals, including trace elements;
- △ Estimating ground water inflows to the river at each site from observing gradients, permeability, and flow cross-section;
- △ Developing a two dimensional cross-section model for each site; and
- △ Integrating the findings to estimate quantity and quality of flows to the river.

10 Load/Flow Relationships

The objectives of this project are to study and identify relationships between irrigation practices and the quantity and quality of drainage water as well as the relationship between quantity and quality of drainage water. An existing drainage model will be modified and used for on-farm and regional prediction purposes. The effect of deep-well pumping on the hydrology of shallow ground water also will be studied.

The Water Conservation Office is in the process of developing a contract with Panoche Water District.

Location
Panoche Water District

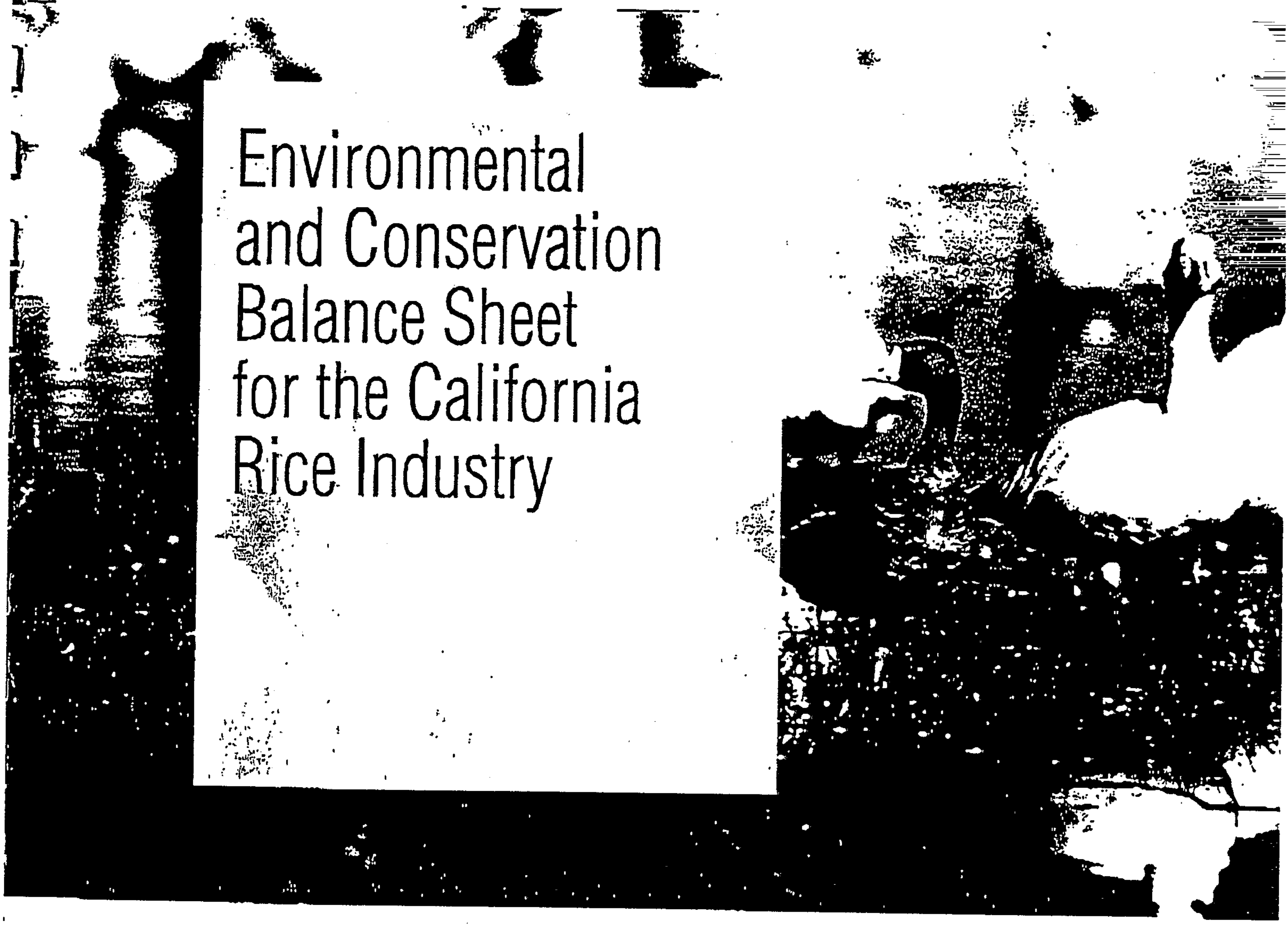
Contractor
Panoche Water District

Cost
$185,000 over three years

Specific work to be performed includes:

- Collecting existing and new data on irrigation and drainage flows;
- Analyzing data to identify relationships between irrigation practices and quantity and quality of drainage water;
- Analyzing data to identify relationships between drainage quantity and drainage quality. This includes load (mass) of selenium, molybdenum, boron, and salinity in drainage water;
- Incorporating current knowledge of solute chemistry and drainage models into a simulation model; and
- Modeling drainage load/flow relationships for simulation purposes on a field scale as well as on a regional scale.

Appendix B



Environmental and Conservation Balance Sheet for the California Rice Industry

Prepared for:
The California Rice Promotion Board

CH2MHILL

August 1996

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C-037030

C-037030

Weed Pest Management

The most widely practiced form of weed control is cultural, which does not involve herbicides. Flooding of rice fields is universal in California, and it is the most effective way to control many weeds. Tillage before rice planting can also be helpful. Timely planting and rapid establishment of rice plants at the proper spacing suppresses weeds by eliminating the space and light that weeds need to grow. California rice farmers are proficient at these techniques of controlling weeds, having perfected efficient methods for planting rice directly onto flooded fields. However, several aquatic weeds can still grow under continuously flooded conditions, so further efforts by the farmer are necessary.

At a somewhat greater cost, other nonchemical control measures are available. A small market for organically grown rice has supported the efforts of some farmers in developing these methods to a great extent. Crop rotation with fallow or nonflooded crops, such as corn or beans, is helpful in some instances because it provides time for some of the seeds shed by the previous seasons' aquatic weeds to die off. This can be expensive because most good rice soils are difficult to farm economically with other crops, and the farmer must own or lease equipment to farm the other crops. Maintaining a deeper flood on the field helps suppress weeds, but requires higher levees as well as additional management and water.

At a relatively lower cost, farmers can control weeds with a variety of selective herbicides (chemicals that, at a prescribed concentration, kill weeds but not rice). A number of effective chemicals have been used by rice farmers over the years. Some have been found to harm other crop plants (MCPA and propanil), or are too mobile in groundwater and surface water (bentazon), and some have been or are being removed from use. Corresponding restrictions for use have been imposed. To avoid conflict with sensitive crops, propanil and MCPA use has been geographically restricted. Bentazon use has been forbidden. Other herbicides are organic compounds that break down over time, do not have mobility or toxicity problems, and have associated management practices that have been developed to ensure that they do not pollute water supplies.

The management practices minimizing the deleterious effects of rice herbicides are based on the following general approach:

- Define acceptable concentrations for the protection of human health and aquatic wildlife resources.
- Reduce concentrations in waterways to levels at or below acceptable concentrations by applying herbicides at appropriate rates or allowing time for their breakdown within the rice field before any water is released into waterways.

Herbicides used in California rice production and their regulatory status are presented in Table 3-2. Triclorpyr is a new herbicide available for use in the 1996 growing season.

Herbicides are applied during various stages of the growth cycle of the rice plant. Molinate can be applied from preflooding through initial tillering (sprouting of multiple stems from each plant). Thiobencarb can be applied at post-emergence through initial tillering. MCPA is applied from tiller initiation through panicle initiation (Flint, et al., 1992).

Figure 3-1 indicates the evolution of water quality criteria and performance goals for molinate and thiobencarb from 1981 through 1995. As knowledge has been gained about the sensitivity of fish species, the California Department of Fish and Game (CDFG) has

Insecticides and herbicides are commonly applied at some phase of rice production to manage pests. The use of these chemicals is intended to control damaging pests and competing plant species. However, if not properly managed, they can cause deleterious effects to nontarget animals and plants and jeopardize human health. For these reasons, environmental regulatory agencies such as the United States Environmental Protection Agency (U.S. EPA) and the California State Water Resources Control Board (SWRCB) through the Central Valley Regional Water Quality Control Board (RWQCB) formulate water quality criteria, river basin plans, and goals for the protection of aquatic life and human health. The California Department of Pesticide Regulation (DPR) is the lead agency for pesticide regulation in California. DPR is required by California law to register and regulate the use of pesticides and protect public health and safety by providing environmentally sound pest management. These criteria, standards, goals, and regulations govern pesticide use by the rice farmer so as to meet the dual goals of effective pest management and environmental integrity.

Animal Pest Management

The primary animal pests of rice in California are tadpole shrimp, crayfish, rice water weevil, leaf miner, midges, army worms, and leafhoppers. Several chemicals can be applied to control these pests and minimize damage. Common insecticides used on specific-target rice pests in California and their regulatory status are presented in Table 3-1.

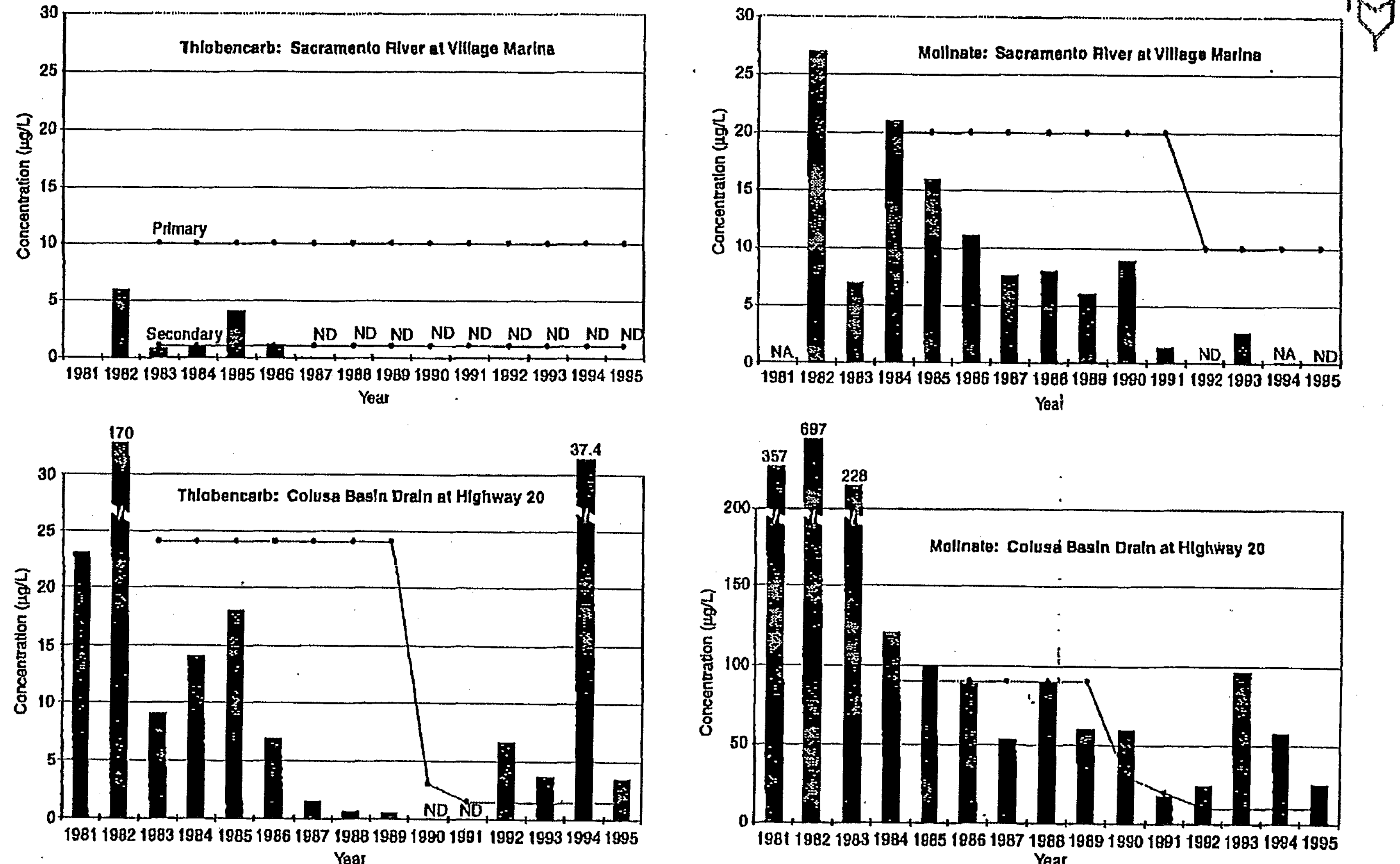
TABLE 3-1
Insecticides Used in Rice Cultivation in California

Chemical Name	Target Pest	Status
Carbofuran	Rice water weevil	Registered, restricted use
Malathion	Midges	Registered, restricted by label
Methyl parathion	Tadpole shrimp, midges	Registered, restricted use
Copper sulfate	Tadpole shrimp	Registered, restricted by label

Malathion and copper sulfate are the only fully registered insecticides with no special restrictions for California rice. The DPR has placed restrictions on the other commonly used insecticides. Restrictions may include holding time limits for discharge water, a permit from the County Agricultural Commissioner to possess or use the pesticide, and limitation of the land area that can be treated. Carbofuran's registration has been extended through the 1996 growing season; however, it will not be renewed for 1997. Growers will nevertheless be able to use available stocks of carbofuran during 1997.

The most intense period of insect and invertebrate pest management is the period between sowing the rice seed and the stand establishment. Carbofuran, used for control of rice water weevil, is applied prior to field flooding or within the first 6 weeks of stand establishment. Other insecticides (malathion, methyl parathion, and copper sulfate) for controlling tadpole shrimp and rice seed midges are also applied in the initial stages of stand development to avoid economic losses of the crop.

C-037032



Legend
ND Not Detected
NA Data Not Available
Peak Concentration
Allowable Maximums (pre-1990) and Performance Goals (1990-1995)

Source: DPR, 1995. Information on Rice Pesticides. Submitted to the Water Quality Control Board. December 28.

1971_02

FIGURE 3-1
TRENDS FOR SACRAMENTO RIVER AND COLUSA DRAIN HERBICIDE STANDARDS AND PEAK LEVELS
THE CALIFORNIA RICE PROMOTION BOARD

CH2MHILL

required lower maximum levels of molinate and thiobencarb in agricultural drains. Research on rice water and weed management, as well as rapid adoption of the new technologies by rice farmers, are aimed at meeting this challenge of protecting water quality. The rice farmers' success in this regard is discussed in the Water Quality Monitoring and Compliance with Performance Goals section.

TABLE 3-2
Herbicides Used in Rice Cultivation in California

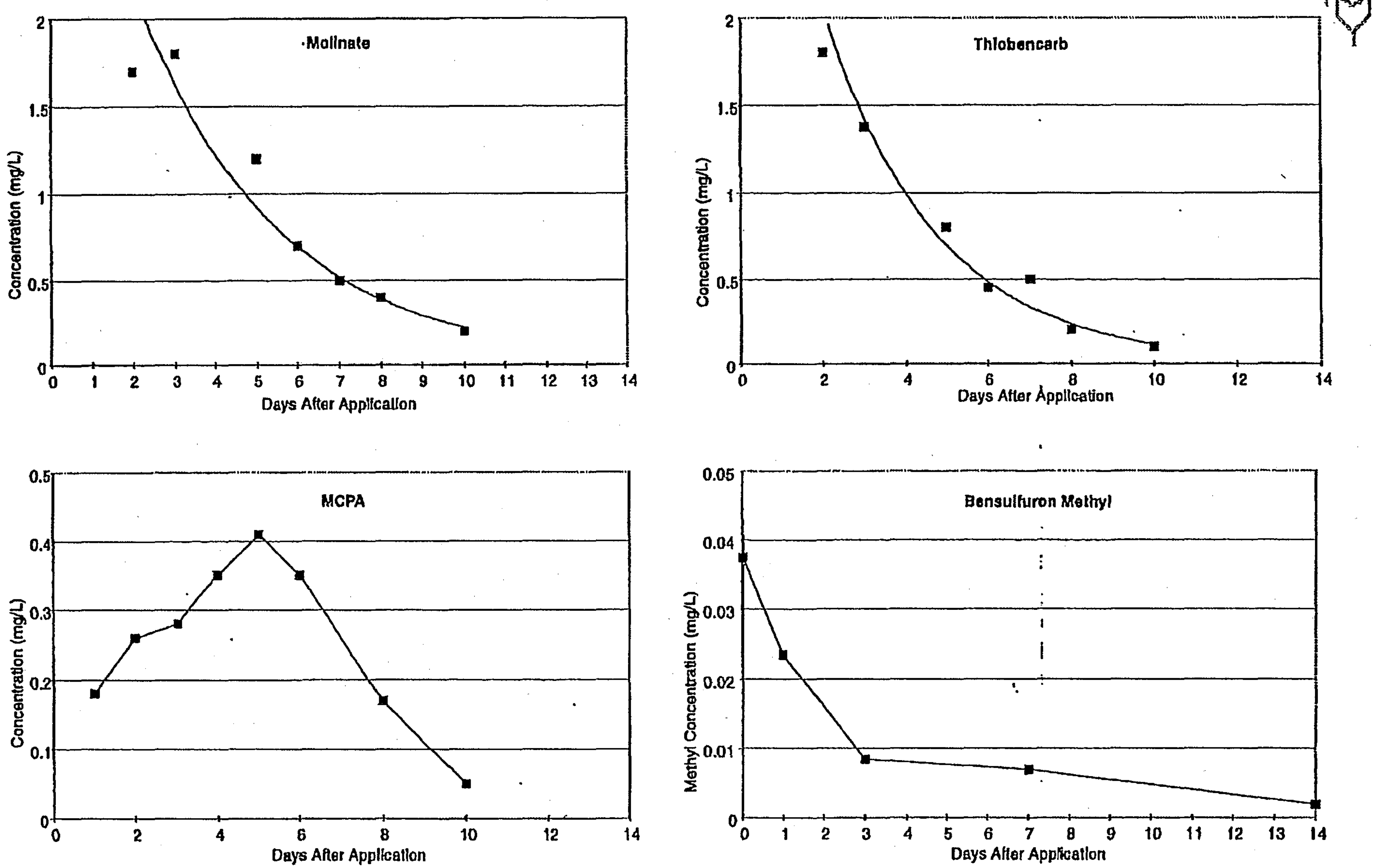
Chemical Name	Target Pest	Status
Bensulfuron methyl	Broadleaf, sedges	Registered, restricted by label
Molinate	Grass weeds	Registered, restricted use
Thiobencarb	Broadleaf, sedges, grass weeds	Registered, restricted use
MCPA	Broadleaf, sedges	Registered, restricted use
2,4,D	Broadleaf, sedges	Registered, restricted use
Fenoxaprop	Broadleaf	Registered, restricted by label
Propanil	Broadleaf, sedges, grass	Registered, restricted use
Triclorpyr	Boadleaf	Registration under public notice

Bensulfuron methyl and fenoxaprop are currently the only fully registered herbicides without any special restrictions for California rice. However, weed resistance to bensulfuron methyl has developed, and this has reduced its usefullness in California rice production. Use of MCPA and 2,4,D is limited to certain areas because these chemicals can damage other types of crops.

The pesticides used in rice production are broken down by natural mechanisms. A principal mechanism is biodegradation. When rice fields are flooded, oxygen flow into the soil is greatly reduced. Below the surface half-inch of soil, microbes rapidly deplete oxygen and begin to seek other compounds for respiration, including sulfur, nitrogen, iron, and manganese. This layering creates a wide range of chemical and microbial conditions that are ideal for breaking down organic compounds like rice herbicides. The extent of destruction depends on how fast these conditions are created and how long they exist. Microbes work well at high water temperatures that are favored by relatively little inflow of fresh, cool irrigation water. Reducing or eliminating flow out of the rice field keeps herbicide in the field where microbes in the soil and the water can degrade it over time. Figure 3-2 shows that after 7 to 10 days, herbicide concentrations are reduced by 80 to 90 percent for all but MCPA. Nevertheless, MCPA levels in return flow have not been a problem.

Several methods have been developed to retain water on flooded fields to aid in herbicide breakdown. Chapter 2 describes the closed and conventional systems and presents a breakdown of the percentage of rice acreage using each system within the rice producing counties.

Prior to 1980, water retention by the closed or conventional systems was rare. Installation of recirculation systems for substantial acreage is an indication of the commitment of rice farmers' resources to water quality (see Chapter 2). For example, the increase in holding times for tailwaters containing molinate from 4 days (post-application) in 1983 to the



Source: U. C. Cooperative Extension, 1991. *Reducing Pesticide Levels from Rice Field Drain Waters of the Sacramento Valley, 1990 Progress Report.*

FIGURE 3-2
RATES OF HERBICIDE BREAKDOWN IN RICE PADDY WATER
THE CALIFORNIA RICE PROMOTION BOARD

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current (1996) practice of 28 days and the encouragement of tailwater recycling practices have contributed to the reduction in molinate loadings to receiving waters in the Sacramento River Basin. A provision of the rice pesticide control program allows emergency releases of pesticide-treated tailwaters prior to the standard holding times (with authorization from the county agricultural commissioner). This program provision has resulted in concerns about the impacts of these releases on surface-water quality downstream of these discharges. A study conducted by the RWQCB in 1991 determined that only 0.8 percent of total rice acreage was granted emergency releases in 1991. However, the RWQCB calculated that these releases accounted for approximately 15 percent of the molinate measured at the Colusa Basin Drain. These findings resulted in restriction of emergency release authorizations unless no other options are available (RWQCB, 1992).

In 1992, the RWQCB requested that the DPR conduct a program to reduce the drift of rice pesticides during aerial application, which contributes to rice pesticides in surface waters adjacent to rice fields. The 1994 program has specific provisions for reducing the effects of aerial drift on water quality. These provisions are based on drift control measures outlined in Section 6460 of Title 3 of the California Code of Regulations, and include additional measures to prevent drift by increasing the average size of spray droplets. The provisions also prohibited application to sites immediately upwind of waterways and to all sites when wind speeds are greater than 5 miles per hour (DPR, 1994). Drift provisions for 1995 were the same as in 1994; however, special attention was given to prevent aerial deposition to sweat ditches during application. Aerial drift provisions for 1996 will remain the same (DPR, 1995).

Other 1992 RWQCB pesticide management recommendations requested DPR to incorporate the practice of sealing weir boxes and field drain structures with canvas to minimize leakage of rice field water during holding periods (RWQCB, 1992). These management recommendations should provide additional benefits in limiting pesticide concentrations in drains and ultimately in the Sacramento River. In 1994, pesticide users were required to prevent seepage of field water through the field's weir box by securing the box with plastic and mounding soil in front of each weir box (DPR, 1994). Field inspectors noted that the new 1994 provision requiring mounding of soil in front of each field's drain box was a valuable enforcement tool.

Criteria and Performance Goal Development

Beginning in May 1980, and on a yearly basis through 1983, over 65,000 carp, catfish, black bass, and crappie died in rice field drain waters in the Sacramento Valley (Hill et al., 1991). At approximately the same time, monitoring studies found that thiobencarb concentrations as low as 1 µg/L resulted in increases in water taste complaints from people whose drinking water originated in the Sacramento River downstream of the rice field agricultural drains.

As a result of the fish loss events in the early 1980s, CDFG conducted investigations that indicated that the fish losses resulted from molinate poisoning (SWRCB, 1990). By implementation of increased holding times for irrigation waters containing molinate, no additional fish losses have been documented since June 1983.

Monitoring studies in the early 1980s by the RWQCB determined that molinate, carbofuran, malathion, and methyl parathion were present in rice field drains in concentrations that

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could cause a threat to aquatic life. As a result of the fish losses and the monitoring results through the early 1980s, the DPR initiated the Rice Pesticide Control Program in 1984 to manage and regulate the discharge of pesticides from rice fields.

Findings by CDFG and RWQCB further moved the SWRCB to contract for scientific studies to develop a toxicity database and to suggest limits for pesticide levels in the Valley's rivers and agricultural drains.

A review of information on toxicity of molinate and thiobencarb was conducted by the SWRCB (1990). This review was used to develop specific water quality criteria and performance goals for those herbicides. The CDFG has also recently completed hazard assessments for the insecticides carbofuran, malathion, and methyl parathion. The results of these investigations support the RWQCB recommended performance goals on the basis of studies by the CDFG laboratory and a review of the toxicity literature (Finlayson, pers. comm., 1992). Presently, the performance goals for the five rice pesticides are only targets and are not enforceable.

In 1990, the RWQCB amended *The Water Quality Control Plan* (Basin Plan) for the Central Valley Region. The Basin Plan prohibited the discharge of irrigation return flows containing molinate, thiobencarb, carbofuran, malathion, and methyl parathion unless a RWQCB-approved management practice is followed. Proposed management practices are intended to control pesticide concentrations in return flows from rice fields so that specific performance goals are met. The RWQCB is currently working on amendments to the existing Basin Plan that would establish enforceable water quality objectives by 1997.

The DPR continues to submit yearly rice pesticide control program results and proposed management practices for these pesticides to meet the RWQCB performance goals. Irrigation water-holding times, guidelines for emergency releases, and voluntary limits on acreage treated are examples of current rice pesticide management practices.

Water Quality Monitoring and Compliance with Performance Goals

Since the early 1980s, major accomplishments have been made in reducing the pesticide and herbicide concentrations in rice field drains. Through voluntary and regulatory programs, the Sacramento Valley rice growers have been successful in significantly reducing the total pesticide loadings into the major drains and the Sacramento River. As a result of these reductions in rice pesticide loadings, residuals are well below public health criteria (no known instances of a threat to human health have been experienced). Potential threats to aquatic life should be further minimized by ongoing efforts to improve water quality.

The RWQCB is charged with protection of water quality in California's rice growing region. This has included enforcement of primary water quality criteria for protection of public health and secondary criteria for water quality, and taste and odor. These criteria are established by the U.S. EPA and the California Department of Health Services (DHS). The CDFG is similarly responsible for protection of fish and wildlife resources. These agencies define safe levels of pollutants, including pesticides, in California's waters and also monitor these pollutants to ensure compliance.

As a result of fish kills in the early 1980s, the DPR (formerly a part of the California Department of Food and Agriculture), the City of Sacramento, RWQCB, and CDFG began intensive monitoring of rice pesticides in the Sacramento Valley. These studies included sampling of agricultural drains, the Sacramento River, and fish tissues in both the drains and the river. These monitoring activities have resulted in the establishment of the current water quality objectives and performance goals for maximum concentrations of pesticides in the surface waters of the Sacramento River Basin. The 1996 performance goals for carbofuran, malathion, molinate, methyl parathion, and thiobencarb are 0.4 µg/L, 0.1 µg/L 10.0 µg/L, 0.13 µg/L, and 1.5 µg/L, respectively (RWQCB, 1994). Seven water quality objectives for pesticides have been defined in the 1994 Basin Plan. Following is a summary of these objectives:

- Pesticides shall not be present in concentrations that adversely affect beneficial uses.
- Discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses.
- Total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical methods.
- Pesticide concentrations shall not exceed the lowest levels technically and economically achievable.
- Waters designated for use as domestic or municipal supply shall not contain concentrations of pesticides in excess of maximum contaminant levels set by the California Code of Regulations.
- Waters designated for use as domestic or municipal supply shall not contain concentrations of thiobencarb in excess of 1.0 µg/L.

Since the early 1980s, rice pesticide and herbicide concentrations have been significantly reduced in both the Sacramento River and the Basin agricultural drains. These reductions have been achieved through continued monitoring of study results, setting of performance goals and water quality objectives, research into rice tailwater management practices, and innovations in rice cultivation practices.

The total herbicide load (molinate and thiobencarb) carried by the Sacramento River dropped from approximately 40,000 pounds in 1982 to less than 125 pounds in 1992 (California Environmental Protection Agency, 1992). In 1993, the molinate load (thiobencarb was not detected in the Sacramento River) carried by the Sacramento River increased to approximately 4,200 pounds, but then decreased again in 1994 to approximately 240 pounds. Figure 3-3 shows the mass loading to the Sacramento River from 1982 to 1995. Weather conditions may explain some of the variations in the peak concentrations and mass loadings. For example, the dissipation rate of some pesticides increases with increasing temperature. Warm weather in May of 1987 and 1992 may explain the low molinate concentrations and mass loading to the Sacramento River during those years. On the other hand, the cool, wet conditions in May of 1990 and June of 1993 may explain the higher levels occurring during those years.

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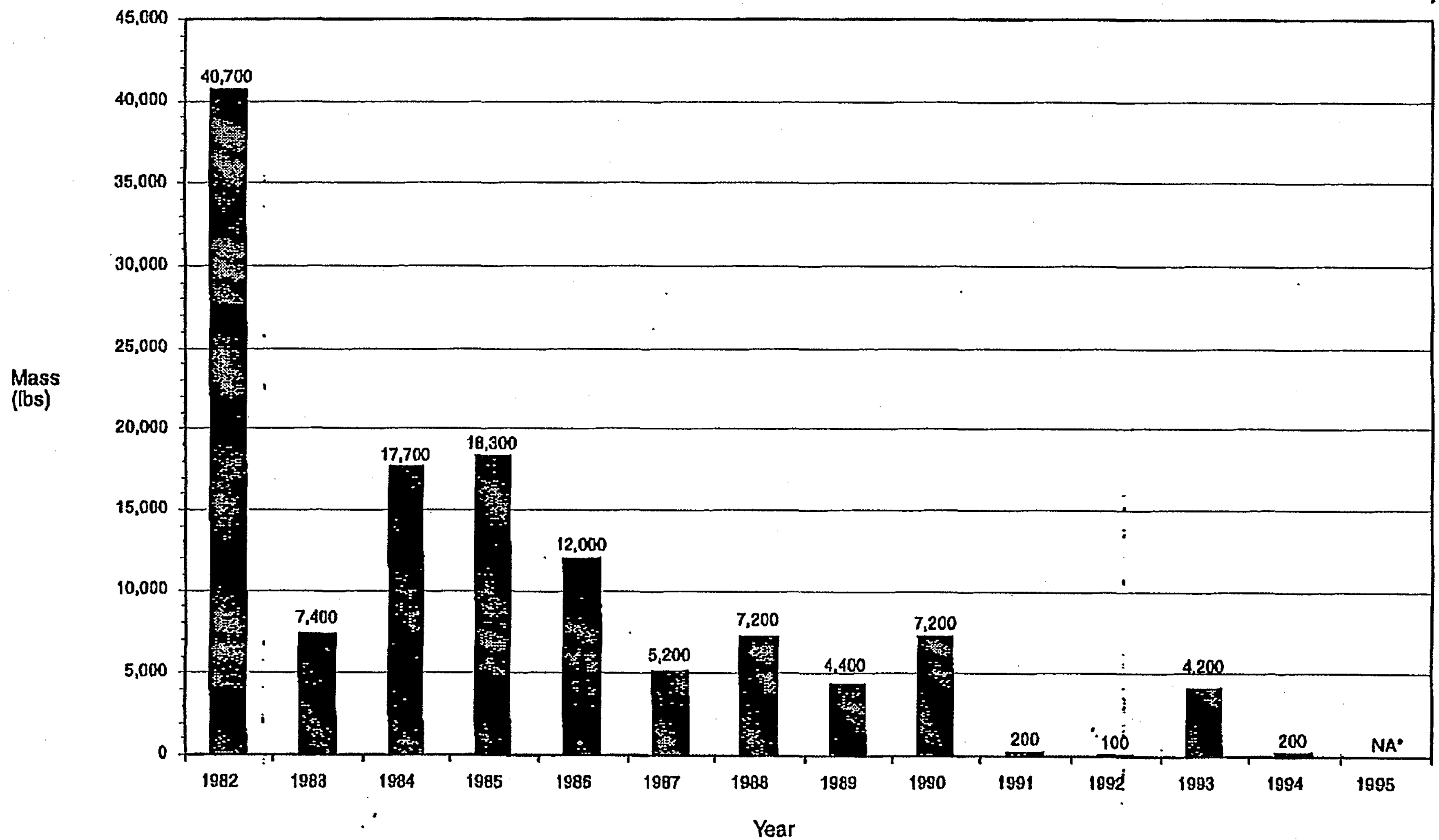

*NA Data Not Available

Source: DPR, 1995. Information on Rice Pesticides. Submitted to the Water Quality Control Board. December 28.

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FIGURE 3-3
ESTIMATED MASS TRANSPORT OF MOLINATE AND THIOBENCARB IN THE SACRAMENTO RIVER
THE CALIFORNIA RICE PROMOTION BOARD

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Seasonal peak levels of two herbicides over the past 15 years are shown in Figure 3-1. Water and weed management systems have changed greatly during this period. Resulting levels of molinate and thiobencarb in the Sacramento River have been below limits established to protect water quality and public health and have generally declined throughout the monitored period (1982 to 1995). Levels of thiobencarb have been below the secondary public health level (taste) since 1986.

Peak levels in the Colusa Basin Drain have also declined (to less than 10 percent of pre-1985 levels). This water is virtually all return flow, mostly from rice fields. Relevant RWQCB goals in this drain are for the protection of fish.

Since 1982, the molinate concentrations in the Colusa Basin Drain at Highway 20 have decreased from a peak of 357 µg/L in 1981 to 25 µg/L in 1995 (Figure 3-1). This has resulted in the reduction of molinate concentrations at the City of Sacramento's water intake from a high of 16 µg/L in 1982 to 0.16 µg/L in 1995, a decrease in concentration of approximately 99 percent (UC Coop. Ext., 1991, DPR, 1995). Drought during the early 1990s resulted in low flows, increasing concentrations of herbicides (Figure 3-1). No Ordram has been detected in the City's drinking water (Cal EPA, 1992). Molinate goals were met between 1986 and 1989, and in 1991.

Molinate goals were exceeded in 1990 as a result of significant reductions in performance goals (from 90 µg/L in 1989 to 30 µg/L in 1990) and drought-related low flows in the drains and rivers.

Thiobencarb goals were met between 1983 and 1991; however, peak levels were above the performance goals between 1992 and 1995. Performance goals have become significantly more stringent, from 24 µg/L in 1989 to 1.5 µg/L in 1991. Thiobencarb concentrations at the City of Sacramento's water intake from 1982 to 1995 have also declined. From peak concentrations of 3 to 4 µg/L in 1985, the concentration of thiobencarb at the City's intake was less than 1.0 µg/L from 1986 to 1995.

The water-holding requirements in the Sacramento Valley in 1995 were adequate to meet performance goals during 1995 and will not be adjusted in 1996. (DPR, 1995).

In lab tests associated with monitoring of rice field drainwater by the CDFG Pesticide Investigations Unit, pesticide levels in the Colusa Basin Drain have not been shown to be toxic. Evidence and experimental data suggest that declines in the striped bass populations in the San Francisco Bay-Delta Estuary since the mid-1970s are probably not a result of rice pesticide use in the Sacramento Valley (Finlayson, pers. comm., 1992).

Conclusions

The California rice industry continues to invest in crop, land, and water management practices that result in reliably high water quality. Their sensitive location in California's water supply network has obliged rice growers to take a proactive approach to water quality. The results demonstrate to other irrigators and industries the potential value of this approach.

The significant reduction in pesticide inputs into the Sacramento River is, "...one of the most successful water pollution control programs in the United States. It has taken concerted effort by numerous state and local agencies and creative implementation by the rice industry to make this happen." *(William Crooks, RWQCB's Executive Officer)*

The following sections present the justification for ratings of the rice industry's performance relative to the environmental value of water quality.

Overall performance of rice relative to water quality values is good. This positive performance is primarily due to irrigation methods that control return flow (surface water flow back to rivers) and limit subsurface drainage discharge, to the capability of rice fields to degrade pesticides, to rice fields' capability to retain plant nutrients, and to low sediment delivery from rice fields. Alternative land uses influence water quality by land drainage, nutrient and pesticide application, machinery spills, home maintenance, and municipal and industrial water use.